R10110616

DOCUMENT INFORMATION

Sheet 1 of 1

The following information is required when submitting a document to PDC for issuance.	Correspondence (CCN) No: 068977 Document No: ______ Rev: ______

Project Information (Check Applicable Box)

☐ Balance of Facilities ☐ HLW Vitrification ☐ Analytical Laboratory ☒ Across all areas
☐ Pretreatment ☐ LAW Vitrification ☐ External Interfaces

Document is applicable to ALARA (as determined by the originator)? ☐ Yes ☒ No

Applicability to ALARA means that the item has the potential to affect doses, contamination levels, or releases to the environment. (See 24590-WTP-GPP-SRAD-002, *Application of ALARA in the Design Process*, sections 4.1 and 4.2 for more information.)

Subject code(s): 4152 (for correspondence only)

ACTION ITEM INFORMATION (for correspondence other than meeting minutes)

Commitments: ☒ Yes ☐ No (if yes, brief description below)

Approve ABARs 24590-WTP-SE-ENS-03-033, Rev. 0 and 24590-WTP-SE-ENS-03-518

Tracked by RITS

Commitment Owed to: ______ Due Date: ______

Actionee(s)			
	R. C. Barr		

Tracked by PADC

Written Response Required: ☒ Yes ☐ No

Owed to: F. Beranek Due Date: October 2, 2003

This correspondence closes action on Correspondence Number ______

☐ Subcontract Files ______ Copies

☐ PAAA Coordinator MS14-4B

☐ Contains SENSITIVE Information

Additional Departmental Info (to facilitate keyword search)

Internal ☐ DNFSB ☐ ORP ☒ OSR ☒ WDOE ☐ WDOH ☐ Other ______

Special Instructions for PDC

09/3/03 ☒ Processed Data Entry ☐ Copied QA ☐ Scanned ☐ Filed

Concurrence Sheet

CCN: 068977

Required Reviewers

Title	Name	Concurrence required (Check appropriately)	Initials	Date
Project Manager	J. P. Betts	☒	[signature]	9/3/03
Deputy Project Manager	A. Beckman	☐		
Operations Manager	S. F. Piccolo	☐		
Engineering Manager	R. J. Tosetti	☐		
Environmental & Nuclear Safety	F. Beranek	☒	FB	9/2/03
Construction Manager	T. L. Horst	☐		
Project Controls Manager	D. S. Hardin	☐		
Business Manager	C. E. Rogers	☐		
Acting Contracts Manager	J. M. Armstead	☒	[signature]	9/2/03
Project QA Manager	G. T. Shell	☐		
HLW Area Project Manager	P. W. Schuetz	☐		
LAW Area Project Manager	W. Clements	☐		
Pretreatment Area Project Manager	R. E. Lawrence	☐		
BOF Area Project Manager	J. Q. Hicks	☐		
Interface Management Manager	T. M. Brown	☐		
Lab Area Project Manager	P. J. Keuhlen	☐		
Process Operations	K. J. Rueter	☐		
Research and Technology	W. L. Tamosaitis	☐		
Commissioning	M. N. Brosee	☐		
Acquisition Services Manager	K. M. Chalmers	☐		
BNI Legal	D. M. Curtis	☐		
Project Manager Special Project 14-3C	H. N. Taylor	☐		

Additional Reviewers

Title	Name	Initials	Date

W. R. Spezialetti	W R Spezialetti	8/28/03
Print/Type Applicable Line Manager's Name	*Signature*	*Date*
T. B. Ryan	Tracey Ryan	8/28/03
Print/Type Originator's Name	*Signature*	*Date*

U.S. Department of Energy
Office of River Protection
Mr. R. J. Schepens
Manager
P.O. Box 450, MSIN H6-60
Richland, Washington 99352

CCN: 068977

SEP 0 3 2003

Dear Mr. Schepens:

CONTRACT NO. DE-AC27-01RV14136 – TRANSMITTAL FOR APPROVAL: AUTHORIZATION BASIS AMENDMENT REQUESTS 24590-WTP-SE-ENS-03-033, REVISION 0, AND 24590-WTP-SE-ENS-03-518, REVISION 0

Reference: CCN 062236, Letter, J. P. Henschel, BNI, to R. J. Schepens (ORP), "Transmittal of Decision to Deviate from the Authorization Basis for the Hanford Tank Waste Treatment and Immobilization Plant," dated August 6, 2003.

Bechtel National, Inc. is submitting Authorization Basis Amendment Requests (ABAR) 24590-WTP-SE-ENS-03-033, Revision 0, and 24590-WTP-SE-ENS-03-518, Revision 0, to the U.S. Department of Energy, Office of River Protection for review and approval. These ABARs propose the following changes to the *Preliminary Safety Analysis Report to Support Construction Authorization; HLW Facility Specific Information*:

- 24590-WTP-SE-ENS-03-033, Revision 0, *Rearrangement and Relocation of HLW Melter Secondary Offgas System* – This ABAR proposes to relocate High-Level Waste (HLW) Facility offgas system components and includes identification of new safety design controls related to the addition of a charcoal bed adsorber for mercury abatement. The use of alternative materials and the assessment of potential inventory controls, as alternative control measures, were identified in the Integrated Safety Management process and are still ongoing. Any revisions in the controls based on these activities will be implemented through the AB maintenance process.
- 24590-WTP-SE-ENS-03-518, Revision 0, *Removal of the HLW ITS 125 VDC Batteries* – This ABAR proposes to remove the three 125 VDC batteries in the HLW annex at the 0 ft elevation that power the Important to Safety breaker control circuits.

Approval of these ABARs is requested by October 2, 2003, to meet the required implementation schedule for reconciliation of Decision to Deviate (24590-HLW-DTD-PL-03-002, Revision 0) from the authorization basis.

Electronic copies of both ABARs and their attachments are provided for DOE's information and use.

Please contact Mr. Bill Spezialetti at 371-3074 for any questions or comments.

Very truly yours,

J. P. Henschel
Project Director

TR/slr

Attachments: 1) Authorization Basis Amendment Request 24590-WTP-SE-ENS-03-033, Revision 0, plus attachments
2) Authorization Basis Amendment Request 24590-WTP-SE-ENS-03-518, Revision 0, plus attachments

cc:

Allen, B. T. w/o	WTP	MS4-B1
Armstead, J. M. w/o	WTP	MS14-3B
Barr, R. C. w/a (1 hard copy and 1 electronic copy)	OSR	H6-60
Beary, M. w/Attachment 1 only	WTP	MS5-K
Beranek, F. w/o	WTP	MS-A1
DOE Correspondence Control w/a	ORP	H6-60
Duncan, G. w/o	WTP	MS4-C2
Ensign, K. R. w/o	ORP	H6-60
Erickson, L. w/o	ORP	H6-60
Eschenberg, J. w/a	ORP	H6-60
Foss, D. w/a	WTP	MS4-B1
Garrett, R. L. w/o	WTP	MS4-B1
Hamel, W. F. w/o	ORP	H6-60
Hanson, A. J. w/o	ORP	H6-60
Klein, D. A. w/o	WTP	MS-A1
Lowry, P. w/o	WTP	MS4-B1
PDC w/a	WTP	MS11-B
Ryan, T. B. w/a	WTP	MS-B1
Shell, G. T. w/o	WTP	MS14-4B
Short, J. J. w/o	ORP	H6-60
Spezialetti, W. R. w/a	WTP	MS-B1
Taylor, W. J. w/a	ORP	H6-60
Tosetti, R. J. w/o	WTP	MS-A2
Toyooka, M. w/Attachment 2 only	WTP	MS5-K
Woolfolk, S. w/a	WTP	MS5-K

Attachment 1

Authorization Basis Amendment Request 24590-WTP-SE-ENS-03-033, Revision 0, plus attachments

Safety Evaluation For Design

Safety Evaluation No.: 24590-WTP-SE-ENS-03-033	**Rev # 0**

Design Document Evaluated:

This ABAR addresses the Reorganization and Relocation of the Secondary Offgas System changes from DTD 24590-HLW-DTD-PL-03-001. The physical reconfiguration is addressed in ABAR 24590-WTP-SE-ENS-03-111. Specifically this ABAR addresses the changes implemented in the documents listed below:

Design Change Application 24590-HLW-DCA-PR-03-003 "Rearrangement and Relocation of HLW Melter Secondary Offgas System" including design drawings:

~~24590-HLW-M6-HOP-00003 HLW Melter Offgas System Melter 1 Secondary Offgas Treatment Sheet 1 of 2, Rev 1~~

~~24590-HLW-M6-HOP-00008 HLW Melter Offgas System Melter 1 Secondary Offgas Treatment Sheet 2 of 2, Rev 1~~

~~24590-HLW-M6-HOP-20003 HLW Melter Offgas System Melter 2 Secondary Offgas Treatment Sheet 1 of 2, Rev 1~~

~~24590-HLW-M6-HOP-20008 HLW Melter Offgas System Melter 2 Secondary Offgas Treatment Sheet 2 of 2, Rev 1~~

24590-HLW-M5-V17T-00004 Process Flow Diagram HLW Vitrification Melter 1 Secondary Offgas Treatment (System HOP), Rev 4

24590-HLW-M5-V17T-20004 Process Flow Diagram HLW Vitrification Melter 2 Secondary Offgas Treatment (System HOP), Rev 0

24590-HLW-P1-P01T-00001 HLW Vitrification Building General Arrangement Plan at EL.-21 ft - 0 in., Rev 2

24590-HLW-P1-P01T-00002 HLW Vitrification Building General Arrangement Plan at EL. 0 ft - 0 in., Rev 1

24590-HLW-P1-P01T-00005 HLW Vitrification Building General Arrangement Plan at EL. 49 ft - 0 in., Rev 1

24590-HLW-P1-P01T-00010 HLW Vitrification Building General Arrangement Section G-G & H-H, Rev 6

Consists of Parts: ☒ 1 ☒ 2 ☒ 3 ☒ 4

Title: Rearrangement and Relocation of HLW Melter Secondary Offgas System

Description of design change:

1. This design change incorporates changes per DCA 24590-HLW-DCA-PR-03-003, "Rearrangement and Relocation of the HLW Melter Secondary Offgas System" including:

   (a) Reorder of the Sequence of Major Offgas Equipment:

Order	*Current*		*New Arrangement*
1	Booster Fan Preheater (Cold Side)	=>	Booster Fans
2	Booster Fans	=>	Activated Carbon Column
3	Catalyst Skid	=>	Booster Fan Preheater (Cold Side)
4	Silver Mordenite Column	=>	Silver Mordenite Column
5	Booster Fan Preheater (Hot Side)	=>	Catalyst Skid
6	Activated Carbon Column	=>	Booster Fan Preheater (Hot Side)
7	Stack Fans	=>	Stack Fans

   (b) The Booster Fan Preheater will be renamed the Silver Mordenite Preheater under the new arrangement.

   (c) Relocate Temperature indicator 0303 upstream of the booster fan (HOP-FAN-00001A/B/B).

   (d) Temperature indicator/controller 0803 will simply be a temperature indicator.

   (e) Temperature indicator 0305 is deleted from the design.

   (f) Relocate analytical indicators 0366, 0365, 0395, 0367, and 0368 to downstream of the stack fans (HOP-FAN-00008A/B/C).

   (g) Delete water spray used for offgas temperature control at the inlet to the activated carbon columns.

   (h) Relocate from the HLW -21ft level, the silver mordenite preheaters in room H-B001C, the catalyst skid in H-B007A for both Melters 1 and 2 to the south side, first floor of the HLW Annex. The activated carbon columns located on the 49 ft elevation, room H-0429 are also moved to the first floor HLW Annex.

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(i) Replaced the individual catalyst skid and silver mordenite bypasses with a common bypass.

(j) Added series/parallel piping, controls, and instrumentation for the activated carbon columns.

2. Incorporate Melter 2 Secondary Offgas Treatment systems per DCA 24590-HLW-DCA-PR-02-021, "Addition of HLW Melter 2" (for 24590-HLW-M6-HOP-20003, 20008 and 24590-HLW-M5-V17T-2004). This system is the same as the Secondary Offgas Treatment System for Melter 1.

Reason for design change:

Item 1 (a)-(g) - This rearrangement removes mercury first to mitigate the mercury poisoning concern in the thermal catalytic oxidizer (TCO) unit and allows for the improved life expectancy of the HLW catalyst skid.

Item 1 (h)- (j) - The relocation of the secondary off gas components consolidates the HLW secondary offgas system, resolves the UBC H-7 occupancy issues, and removes potential carbon dust concerns in the main facility during maintenance. The series/parallel piping around the activated carbon columns allows for operational flexibility.

Item 2 - Add the Secondary Offgas Treatment system to support the addition of Melter 2 per DCA 24590-HLW-DCA-PR-02-021, "Addition of HLW Melter 2" pending approval of SE 24590-WTP-SE-ENS-02-045.

Complete the following parts as appropriate:

Part 1 Safety Screening

Complete Part 1 for all design changes requiring this form. Refer to Appendix 2 of 24590-WTP-GPP-SREG-002 for guidance. If all Part 1 answers are 'No', or for a 'Yes' answer the design is safe and consistent with the AB, the design change does not require further safety review or an AB change. If this is the case, sign this form after Part 1 and submit to PDC. After each question briefly describe the basis for each answer..

		YES	NO
1.	Does the change modify or delete a standard prescribed in the *Safety Requirements Document Volume II* (SRD)?	☐	☒
	Basis: These item 1 revisions of the drawings do not involve changes to standards or requirements identified in the SRD. The item 2 addition of Melter 2 systems is addressed by the safety evaluation pending approval, 24590-WTP-SE-ENS-02-045.		
2.	Does the change alter the location, function, or reliability of an SSC as described in the AB? *This question refers to SSCs described in the LCAR and PSAR, including text descriptions and tables in chapter 2 of the PSAR.*	☒	☐
	Basis: The item 1 reconfiguration of the secondary offgas treatment components does not change the function or reliability of the SSCs but does affect the process order described in the PSAR. The piping system changes in Item 1 provide operational flexability and overall process improvements that are consistent with the described system characteristics. This change alters the location of the preheaters upstream of silver mordenite column and the catalyst skid described in the PSAR from the HLW -21 ft elevation to the first floor, south side of the HLW Annex. The columns of activated carbon on the 49 ft elevation are also moved to the HLW Annex. Although changes to the HVAC distribution are required, the location, function, or reliability of the HVAC is not affected and is consistent with the AB. (See description of the DCA.) Item 2 changes adding the Melter 2 systems are on hold and are addressed by the safety evaluation pending approval, 24590-WTP-SE-ENS-02-045.		
3.	Is there a change in classification, new items being classified, or existing items deleted as described in the PSAR?	☒	☐
	Basis: For item 1, there are new items being classified to mitigate a carbon bed fire. Item 2 changes adding the Melter 2 systems are on hold and are addressed by the safety evaluation pending approval, 24590-WTP-SE-ENS-02-045.		

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4.	Does the change affect the safety function descriptions in chapter 4 of the PSAR?	☒	☐
	Basis: Item 1 changes add new equipment with safety functions not described in Chapter 4 used in the control strategy to mitigate a new hazard. Item 2 changes adding the Melter 2 systems are on hold and are addressed by the safety evaluation pending approval, 24590-WTP-SE-ENS-02-045.		
5.	Does the change create a new hazard or affect the hazard or accident analysis contained in the PSAR?	☒	☐
	Basis: The Item 1 reorder of the components of the secondary offgas system introduces a new potential for a fire with the sulfur-impregnated activated carbon in the mercury adsorption system. The fire vaporizes mercury, mercury compounds, and oxides of sulfur. These hazards are addressed in Part 2 of this safety evaluation. The piping changes provide operational flexibility and do not affect the hazards or accident analysis. Item 2 changes adding the Melter 2 systems are on hold and are addressed by the safety evaluation pending approval, 24590-WTP-SE-ENS-02-045.		
6.	Does the change affect criticality safety?	☐	☒
	Basis: These Item 1 changes to the secondary offgas system do not affect credited parameters in the CSER WTP-RPT-NS-01-001, Rev 2. The Item 2 addition of Melter 2 systems is addressed in the pending safety evaluation, 24590-WTP-SE-ENS-02-045.		
7.	Does the change have the ability to affect exposures to radiation (doses), contamination levels, or releases of radioactivity to the environment? If so, has an ADR been completed?	☒	☐
	Basis: These Item 1 changes to relocate and rearrange the secondary offgas systems are evaluated by Rev 1 of ADR 24590-HLW-ADR-M-03-001. The Item 2 addition of Melter 2 systems is addressed in the pending safety evaluation, 24590-WTP-SE-ENS-02-045.		
8.	Are any other Authorization Basis documents affected by this change?	☒	☐
	Basis: The Item 1 changes are consistent with the other AB documents. None of the responses recorded in the OSR PCAR/CAR Implementation Database (OPCID) are specific to the issues raised by reconfiguration and relocation of the mercury adsorber, silver mordenite preheater, and the catalyst skid. The Item 2 changes adding the Melter 2 systems are on hold and are addressed by the safety evaluation pending approval, 24590-WTP-SE-ENS-02-045.		
9.	As a result of this design change, is an ISM meeting required?	☒	☐
	Basis: This change relocates the secondary offgas systems to the HLW Annex. The Item 1 reorder of the components of the secondary offgas system introduces a new potential for fire with the carbon in a mercury absorption system. On this basis, ISM meetings were held to evaluate new safety issues and a HAZOP study of the reconfigured system was completed and reported in 24590-HLW-SIN-03-003. The Item 2 changes adding the Melter 2 systems are on hold and are addressed by the safety evaluation pending approval, 24590-WTP-SE-ENS-02-045.		

Safety Evaluation For Design

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Further safety review required? ☒ Yes ☐ No

AB change required? ☒ Yes ☐ No

If either answer above is 'Yes', continue with this form. If both answers are 'No', sign here and send Part 1 of this form to PDC.

Safety Evaluation Preparer:	Raliegh M. Nakao	Raliegh M. Nakao	9/2/03
	Print/Type Name	*Signature*	*Date*
Design Document Originator/ Supervisor:	Jim Rouse	Jim Rouse	9/2/03
	Print/Type Name	*Signature*	*Date*
Only required for screenings requiring NO ABCN or ABAR: H&SA Lead:	N/A		
	Print/Type Name	*Signature*	*Date*

Part 2 Safety Evaluation (Complete Part 2 for all AB changes)

Complete Part 2 to determine the approval authority for the AB change. Obtain concurrence from H&SA Lead.

REGULATORY		YES	NO
1.	Based on the answers to the above technical questions and any other analysis, does the change create a new DBE?	☒	☐
	Basis: A new DBE is created by the addition of a mercury adsorber containing a media of sulfur-impregnated activated carbon. The HLW melter offgas HAZOP study reviewed the mercury adsorber in its current location downstream of the primary booster fans (see 24590-HLW-SIN-ENS-03-003, Draft). The deviation generated from the guide word "High" and process parameter "Temperature" generated two causes: 1) organics in offgas cause localized high temperature in bed, and 2) high relative humidity causes sulfur vaporization due to localized heating. For the deviation generated by the guide word "Low" and the process parameter "Temperature", the HAZOP team generated two more deviations: 1) operator error - failure to initiate startup heater sequence causes localized heating due to moisture on fresh activated carbon, and 2) failure of HEPA pre-heater causes localized heating (hot spots) due to moisture on fresh activated carbon. The guide word "No" and the process parameter "Flow" resulted in five additional fire scenarios. The initiators are: 1) plugged bed, 2) deposition of ammonium nitrate, 3) operator error - valve misalignment, 4) valve failure - equipment failure, and 5) attrition of bed. The consequence of these events are loss of offgas flow and possible fire due to no flow. All fire scenarios result in the vaporization of mercury and sulfur dioxide. Leaks into a C3 area, a HAZOP deviation in the mercury adsorber worksheet, are caused by localized hot spots from the previously mentioned events and it is the localized hot spots that cause structural damage. The deposition of ammonium nitrate is addressed in the PNNL letter report CCN: 065240. The authors of the PNNL report found that the relocation of the activated carbon column downstream of the HEPA filters/fans results in a low potential for ammonium nitrate accumulation in the carbon bed (pg 105). Acid washing removes impurities that are associated with an increase in fire hazard. This was addressed in the LAW HAZOP in the requirement for verification that the activated carbon media meets the specification and the specification requirement for acid washing.		

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2.	Based on the answers to the above technical questions and any other analysis, does the change result in more than a minimal (≥ 10 %) increase in the frequency or consequence of an analyzed DBE as described in the Safety Analysis Report?	☒	☐
	Basis: The calculation 34590-HLW-Z0C-30-00007 was revised to include an analysis of the fire in the activated carbon column and the subsequent release of mercury and sulfur dioxide. The event analyzed is from CSD-HHOP/N0030, "Organics in the offgas cause localized high temperature in the carbon bed." As specified in section 3.2 of 24590-WTP-GPG-SANA-004, the applicable consequence threshold for the co-located worker is the ERPG-3 (*The AIHA 2001Emergency Response Planning Guidelines and Workplace Environmental Exposure Level Guides Handbook,* American Industrial Hygiene Association, Fairfax, Virginia.) or TEEL-3 (*ERPGs and TEELs for Chemicals of Concern: Rev 17m, WSMS-SAE-00-0266,* Westinghouse Safety Management Solutions, Aiken, SC) value for the substance. The TEEL-3 value for mercury is 10 mg/m^3. The unmitigated consequences of this mercury release exceed the specified consequence threshold by more than two orders of magnitude. The event is therefore designated "Above Threshold" (AT). The ERPG-3 value for sulfur dioxide is 15 ppm (or 39.2 mg/m^3). The unmitigated consequences of this sulfur dioxide release exceed the specified consequence threshold by more than an order of magnitude. The event is therefore designated "Above Threshold" (AT). The public consequences of the SO_2 release do not exceed the specified consequence threshold (ERPG-2 value) of 3 ppm (7.8 mg/m^3). The systems, structures, and components which comprise ITS barriers credited in this DBE analysis that must meet the specific functional requirements are the carbon monoxide monitor (SCR-HINST/N0025) and the water deluge system (SCR-HFIRE/N0009).		
3.	Based on the answers to the above technical questions and any other analysis, does the change result in more than a minimal decrease in the safety functions of important-to-safety SSCs or change how a Safety Design Class SSC meets its respective safety function?	☐	☒
	Basis: The SDS items discussed in this section [4.4.3 of the PSAR] are as follows: • Vessel vent system ductwork from the vessels up to the melter offgas ductwork • Melter offgas ductwork including the SBS, WESP, HEME, pressure boundary, HEPA filter housings up to the exhaust stack • HEPA filters and preheaters • Exhaust fans An internal fire causing failure of the pressure boundary up to the exhaust stack was not previously anticipitated or analyzed. However, this event was addressed in the HLW melter offgas system HAZOP study, CCN: 52607, and reported in draft document, 24590-HLW-SIN-ENS-03-003. A recommendation of the HLW melter offgas HAZOP study was the installation of a deluge system specifically designed to contain a fire in the activated carbon column. The deluge system is actuated on detection of a high carbon monoxide level in the exhaust from the mercury adsorber (SCR-HINST/N0025, "Carbon monoxide monitor actuates the water deluge system in the mercury adsorber extinguishing fire in the bed of activated carbon"). Based on the DBE analysis of a fire in the activated carbon, the event is AT. ***Nitrated Material*** Another safety concern is the adsorption of NOx, an oxidizer in a fuel rich system, or the deposition of ammonium nitrate, a substance that is an explosive under favorable conditions. As a result of ongoing investigations, it is known from Nucon (a vendor of activated carbon) that high NOx levels (greater than percent levels) may be a concern because of potential reactions with oxide and carbonate impurities in the activated carbon. The NOx level in the HLW melter offgas system is less than one percent; the estimated maximum concentration is a maximum of 0.2% NOx (DOE briefing 6/5/03). Nucon also confirmed that acid washing effectively removes oxide and carbonate impurities. A HAZOP study performed on the LAW melter offgas recommended verification on receipt		

of activated carbon indicating that the specification requirements have been satisfied. A specification requirement that mitigates nitration of activated carbon is acid washing. The requirement for verification of the specification requirement which includes acid washing for activated carbon will apply to both LAW and HLW facilities and is found in SCR-HADM/N0007.

Work on the affect of NOx on the mercury adsorber has been conducted at INEEL and summarized in an e-mail from Dr. Steve Priebe to Tom Valenti (CCN: 050045). Dr. Priebe reported that in several experiments with high NOx concentrations, there was no observed effects on the carbon bed. He did recommend further testing, which is planned, and stated in summary that there is sufficient data and information to reliably state that the reaction between sulfur-impregnated activated carbon and NOx will not pose a safety or operational problem.

Gunpowder The mercury adsorbent is sulfur-impregnated activated carbon. If a nitrate compound was sorbed or initially present on the activated carbon media, then the composition is comparable to gunpowder. The formation of nitrated compounds as previously discussed, is negated by low concentrations of NOx and acid washing. Testing of sulfur-impregnated activated carbon and in the presence of high NOx concentration found no safety or operational problem.

Ammonium Nitrate The summary of the PNNL letter report (CCN: 065240) states, "Within the LAW offgas system, the movement of the carbon beds from it previous position downstream of the caustic scrubber to a position following the HEPA Filters/Fans results in a significant reduction in the potential for ammonium nitrate formation and accumulation in the carbon bed. Rapid reaction of any residual ammonia downstream of the Wet Electrostatic Precipitator (WESP) is predicted for all conditions considered."

Equipment inspections are planned at Vitreous State Labs (VSL), Catholic University, to measure ammonium nitrate deposition. The new location of the mercury adsorber, downstream of the SBS, is at a point in the process where the ammonium nitrate is very low. The HLW summary section of the PNNL report states that "from the melter to the Fan Preheater HX, the flowsheet is high in NO_2 (~550 ppm at SBS exit) such that high reaction rates are predicted. With the high reaction rate and relatively low ammonia concentration, the reaction is expected to be sufficiently fast that the ammonia would react to an equilibrium concentration level before exiting the WESP. Thus, nearly all the ammonium nitrate would be collected in the WESP, eliminating the potential for ammonium formation at location downstream from the WESP until ammonia is added again in the SCR for NOx reduction" (CCN: 065240, pg 7.22). This change does not represent an improvement with respect to ammonium nitrate in the bed. Before the change, the carbon bed was in a location where elevated temperature precluded ammonium nitrate formation. However, the small residual ammonia concentration indicated in the flowsheet is not predicted to be present downstream of the high efficiency mist eliminator (HEME). "After HEPA filtration, the gas will be heated as it passes through the blower to a temperature greater than the filtration temperature, shifting equilibrium away from solid ammonium nitrate. This makes it very unlikely that ammonium nitrate would form within the carbon bed (CCN: 065240, pg 3.8)."

Ammonia Line Break An ammonia line break was analyzed in the HLW melter offgas HAZOP study. A recommendation of the HAZOP team was to verify that ammonia monitors are installed in occupied areas and in locations in the occupied areas that ensure the safety of the worker. It was also recommended that a study be performed to determine if an ammonia line leak or rupture could cause the ammonia concentration to exceed the lower flammability limit.

Conclusion The question of whether the reconfigured location is cause for a minimal decrease in safety cannot be answered with complete certainty because of the plans for additional testing and inspections. However, there is sufficient information to conclude that a minimal decrease in safety is unlikely. A decrease in safety, with respect to this change, is

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	defined as an event that threatens the pressure boundary and is unmitigated; or there are insufficient assurances that the pressure boundary can be maintained given the change in offgas composition as a result of moving the mercury adsorber to a new location. The fire initiated breach of the mercury adsorber is mitigated by the HAZOP recommendation requiring a deluge system. Two standards were identified, ASME 31.3 for the supply of water and AG-1 for firewater flow requirement (CCN: 065429). The addition of a deluge system is in keeping with the best commercial practice. NOx as an initiator or enabler in the combustion or detonation of sulfur-impregnated activated carbon is removed by acid washing of the fresh activated carbon to remove oxides and carbonates impurities that react with NOx (see SCR-HADM/N0007). The concentration of NOx in the HLW offgas is below the concentration of concern as defined by a prominent vendor. In briefing notes presented to DOE, the HLW offgas has a maximum NOx concentration of 0.2%. This is a factor of 5 less than the percent levels that Nucon, an activated carbon supplier, identified as being a level of potential concern because of oxide and carbonate impurities. Those impurities will be removed by acid washing.		
4.	Does the change result in a noncompliance with applicable laws and regulations (i.e., 10 CFR 820, 830, and 835) or nonconformance to top-level safety standards (i.e., DOE/RL-96-0006)?	☐	☒
	Basis: 10 CFR 820, *Procedural Rules for DOE Nuclear Activities,* sets forth the procedural rules for the conduct of persons working to comply with DOE safety compliance. This safety evaluation of the reconfiguration of the HLW melter offgas system is prepared to approved procedure, 24590-WTP-GPP-SREG-002, which was established in accordance with DOE orders and requirements. A violation or enforcement, of 10 CFR 820 is not an issue. The reconfiguration does not require an exemption from safety requirements. Supply of equipment is not an issue, hence reporting of supplier defective products or inaccurate or incomplete information is not germane. 10 CFR 830, *Nuclear Safety Management*, requires establishment and maintenance of safety bases and classifies QA work requirements applicable to standards and controls adopted to meet regulatory or contract requirements that may affect nuclear safety. Hazards have been identified and controlled in accordance with 830.202. 10 CFR 835, *Occupational Radiation Protection*, sets forth rules to establish radiation protection standards, limits, and program requirements for protecting individuals from radiation resulting from conduct of DOE activities. Radiation protection standards, limits and programs are not applicable to this design change. The relocation of the mercury adsorber conforms to the top-level standards of DOE/RL-96-0006.		
5.	Does the change fail to provide adequate safety?	☐	☒
	Basis: Adequate safety is provided in the reconfiguration of the HLW melter offgas system. Briefly iterating the discussion from question 3 above regarding safety concerns and safeguards, it was noted that the recommendation from the HLW melter offgas HAZOP study was to specify a mercury adsorber with a CO monitor actuated deluge system. This action item was finalized in a separate ISM on HAZOP action items (see draft 24590-HLW-SIN-ENS-03-033 and CCN: 057990). An exothermic reaction of NOx with the sulfur-impregnated activated carbon bed is prevented by specifying acid washing of the activated carbon to remove reactive impurities, the low concentration of ammonia, and the effectiveness of the WESP in removing ammonium nitrate and the HEME in removing residual ammonia. The mercury adsorber vessel retains the SDS, SC-III classification as designated in Section 4.4.3 of the PSAR. The toxic impact from a melter-offgas release is outside the scope of the ORA. The seismic PRA is unaffected by the re-configuration of melter offgas system components. Thus, there is no significant negative impact on safety.		

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6.	Does the change result in nonconformance to the contract requirements associated with the authorization basis document(s) affected by the change? See Contract Standard 7(e)(2).	☒	☐
	Basis: Standard 7(e)(2) requires as primary objectives of ESQ&H to: (1) Demonstrate compliance with established requirements; (2) Apply best commercial practices to provide conventional non-radiological worker safety and health protection; radiological, nuclear, and process safety, and environmental protection; and (3) Implement a cost-effective program that integrates environmental protection, safety, quality, and health in all Contractor activities. The ISM process and AB maintenance are established requirements that undergird the reconfiguration of the HLW melter offgas system. A deluge system in the mercury adsorber is application of the best commercial practice. And, the re-arrangement of the offgas components is cost effective in making effective use of space within the building.		
7.	Does the change result in an inconsistency with other commitments and descriptions contained in portions of the authorization basis or an authorization agreement not being revised?	☒	☐
	Basis: Questions regarding the deposition of ammonium nitrate and NOx were raised by the OSR and recorded in the OSR PCAR/CAR Implementation Database (OPCID). None of the responses are specific to the issues raised by reconfiguration and relocation of the mercury adsorber, silver mordenite preheater, and the catalyst skid. In HLW-PSAR-024, deposition of ammonium nitrate in the heat exchanger/economizer upstream of the SCR was raised as a concern. The SCR offgas is recycled through this heat exchanger to raise the temperature of gas entering the SCR. The location of the heat recovery unit as discussed in PSAR-024 is unchanged by the reconfiguration. The deposition of ammonium nitrate in the heat recovery unit is not to expected based on the results of the PNNL letter report (CCN: 065240). It was noted in the response to PSAR-027 that the TOC (total organic carbon - primarily from sucrose addition) decomposes nitrates to nitrogen and water. The relocation and reconfiguration are not in conflict with this response. The OSR in PSAR-064 observed that a combination of organics, ammonia, and NOx can lead to the formation of explosive deposits/conditions if the equipment is not properly designed and operated. This question was raised with regard to the organic produced in the melter and the destruction efficiency of the Thermal Catalytic Oxidizer. In the new configuration, the activated carbon adsorber is upstream of the Thermal Catalytic Oxidizer and the SCR. Since a primary use of activated carbon is the adsorption of volatile organics, the mercury adsorber will remove some of the volatile organics generated in the melter. Based on the information from Nucon and INEEL, a reaction of organics with NOx is unlikely due to the low concentration of NOx in the melter offgas and acid wash of the activated carbon media.		

*If all Part 2 questions are answered 'No', a BNI-approved AB change (ABCN) is permitted. Complete Part 3 of this form and send it to the E&NS AB Coordinator. If any Part 2 question is answered 'Yes', a DOE-approved AB change (ABAR) is required. Complete Parts 3 **AND** 4 of this form and send to the E&NS AB coordinator.*

BNI-approved AB change? ☐ Yes ☒ No

DOE-approved AB change? ☒ Yes ☐ No

Concurrence:	Initial	Date
H&SA Lead: RLG 9/2/03	[signature]	9/2/03

Safety Evaluation For Design

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Part 3 BNI-Approved AB Change

List affected AB documents, obtain necessary concurrences and approval, and send this form to the E&NS AB coordinator. If an SRD change is involved, obtain PMT and PSC reviews.

Affected Authorization Basis Documents:

Title	Document Number	Rev	Section
Preliminary Safety Analysis Report to Support Construction, HLW Facility Specific Information	24590-WTP-PSAR-ESH-01-002-04	0c	2.4.11, 2.4.12, 2.5.3, 3.3.1, 3.3.3, 3.4, 3.4.1, 3.8, Tables 3-4, 3-5, and 3-23, 4.3.5, 4.4.3, Tables 4-1 and 4-2
Melter Offgas (HOP) System AB Compliance	24590-WTP-ABCN-ENS-02-047	0	2.5.3.4

Concurrences: (check affected departments)

Review Required?	Organization	Print / Type Name	Signature	Date
☒	Safety Evaluation Preparer	Mickey Beary	Mickey Beary	9/2/03
☒	AB Document Custodian	Donavon Foss	[signature]	8/28/03
☐	Quality Assurance			
☒	Engineering	Dilip Patel	[signature]	9/2/03
☒	Affected Area Project Manager	Phil Schuetz	[signature]	9/2/03
☒	Operations	Cindy Beaumier	[signature]	9/2/03
☐	Construction			

Other Affected Organizations	Print / Type Name	Signature	Date
Mechanical Systems	Marla Wright	M. Wright	9/2/03
Plant Design	Dave Gott	David Gott	9/2/03

BNI-Approved AB Change Approved:

E&NS Manager:	Fred Beranek	[signature]	9/2/03
	Print/Type Name	*Signature*	*Date*

Safety Evaluation No.: 24590-WTP-SE-ENS-03-033 **Rev # 0**

Part 4 DOE-Approved AB change

Decision to deviate: ☐ Yes ☒ No

If 'Yes', DTD No.: ____________ Rev: ________

List the AB change implementing activities and the projected completion dates:

Activity	Date
Inform DOE that AB has been revised and formally transmit electronic version	30 days or less after DOE approval
Distribute revised controlled copy pages / update WTP Electronic Library	30 days after DOE approval

Revise the following implementing documents:

Documents	Describe extent of revisions	Date
1 System Description for HLW Melter Offgas Treatment Process and Process Vessel Vent Extraction (HOP and PVV Systems) 24590-HLW-3YD-HOP-00001, Rev 0	Chapters 3, 4, 6, 7, 8, and 10 will require revisions	60 days after DOE approval of this ABAR
2 Revise Design documents evaluated	Reorder and relocate Secondary Offgas System	30 days after DOE approval

Describe other activities	Date
1 N/A	

Concurrence/confirmation of AB change if SRD is changed:

PMT Chair: N/A

Print/Type Name *Signature* *Date*

PSC Chair: N/A

Print/Type Name *Signature* *Date*

Certification of Continued SRD Adequacy:

If this ABAR involves the deletion or modification of a safety criterion, code, or standard previously identified or established in the SRD, Project Director certification is required. The Project Director's signature certifies that the revised SRD continues to identify a set of standards that provides adequate safety, complies with WTP applicable laws and regulations, and conforms with top-level safety standards and principles. This certification is based on adherence to the DOE/RL-96-0004 standards identification process and successful completion of review and confirmation by the PSC.

WTP Project Director: N/A

Print/Type Name *Signature* *Date*

Attachments:

Attachment 1 - Proposed Changes to the Preliminary Safety Analysis Report to Support Construction Authorization; HLW Facility Specific Information (24590-WTP-PSAR-ESH-01-002-04) Sections 2, 3, 4 (41 pages)

Attachment 1

Proposed Changes to the Preliminary Safety Analysis Report to Support Construction Authorization; HLW Facility Specific Information (24590-WTP-PSAR-ESH-01-002-04)

Document Part	Title	Affected Pages
Section 2	Facility Description	2-16, 2-17, 2-28, 2-46, 2-47, 2-50 through 2-53
Section 3	Hazard and Accident Analyses	3-1, 3-5, 3-8 through 3-10, 3-16, 3-17, 3-57 through 3-66, 3-208, 3-216, 3-217, 3-219 through 3-221, 3-254
Section 4	Important to Safety Structures, Systems, and Components	4-12, 4-36, 4-37, 4-39, 4-40, 4-65, 4-66

# of pages (including cover sheet): 41

Based on the composition of the effluent, the waste will be transferred to one of two vessels at the PT facility by the plant wash transfer ejectors. The vessel also overflows to a sump. The plant wash and drains vessel is equipped with the following:

- Pulse jet mixers (section 2.4.17)
- Pressure, level, density, and temperature measurement
- Fluidic samplers (section 2.4.17)
- Steam ejectors (section 2.4.17)
- Internal wash rings and emptying ejectors

2.4.11.1.4 Decontamination Effluent Collection Vessel, RLD-VSL-00001

The decontamination effluent collection vessel receives HLW canister decontamination waste from the waste neutralization vessel. The vessel is constructed of stainless steel. The effluent will be transferred to the PT facility. The decontamination effluent collection vessel overflows to a sump. The decontamination effluent collection vessel is equipped with the following:

- Pulse jet mixers (section 2.4.17)
- Pressure, level, density, and temperature measurement
- Fluidic samplers (section 2.4.17)
- Steam ejectors (section 2.4.17)
- Internal wash rings and emptying ejectors

2.4.11.1.5 Offgas Drains Collection Vessel, RLD-VSL-00002

The offgas drains collection vessel collects condensate from the vessel ventilation ducts. This vessel is constructed of stainless steel. The liquid collected in this vessel is transferred to the plant wash and drains vessel. The offgas drains collection vessel is equipped with the following:

- Pressure, temperature, level, and density measurement
- Steam ejector (section 2.4.17)
- Overflow to the cell
- Internal wash rings and emptying ejectors

2.4.11.2 Secondary Offgas, H-B001A, H-B0001B, H-B0001C

The secondary offgas rooms are at the -21 ft level in the northwest area of the facility (Figures 2A-1, 2A-7, and 2A-10). The secondary offgas system receives the combined primary and vessel ventilation offgas stream discharge. The secondary offgas system will treat the combined offgas so that it is acceptable for discharge to the stack. The secondary offgas rooms are designated as C3 areas. The following are the primary components associated with the secondary offgas rooms.

- Silver mordenite columns - associated with the catalytic secondary offgas system

~~Booster fan preheater - in the same room as the banks~~

- Booster extraction fans - three HLW melter offgas booster extraction fans per melter

2.4.11.3 Submerged Bed Scrubber Drain Collection Cell, H-B0021

The drain collection cell will be operable at the -21 foot level. The cell will be below the melter cave. The floor, ceiling, and walls are of reinforced concrete or steel. The cell floor is sloped to a sump, with level indication, that can be pumped using installed steam ejectors. The cell floor, sump, and lower walls are lined with stainless steel.

This cell contains high activity melter offgas condensate waste, and is designated a C5 area. There are no personnel or equipment access ways (such as shield doors or hatches) to the cell. The cell is exhausted by the C5 ventilation system and is maintained at a negative pressure with respect to areas of lesser contamination potential. The cell will contain a SBS condensate receiver vessel. Figure 2A-1 illustrates the location of a future cell if a second melter system is deemed necessary.

2.4.11.3.1 Submerged Bed Scrubber Condensate Receiver Vessel, HOP-VSL-00903

The vessel collects liquids from the SBS, WESP, and HEME. The vessel is constructed of alloy C-22. The vessel will be operated at a vacuum relative to the cell and vented to the SBS. The vessel is equipped with the following:

- Pulse jet mixer (section 2.4.17)
- Fluidic pumps (section 2.4.17)
- Fluidic sampler (section 2.4.17)
- Level, density, pressure, and temperature measurement
- Cooling water jacket

Wash rings and emptying ejectors (section 2.4.17)

~~2.4.11.4Secondary Offgas Oxidizer Room,H-B007A~~

~~Located at the -21 ft level is the secondary offgas oxidizer room (Figures 2A-1, 2A-7, and 2A-10). The catalyst skids are located in this room. The catalyst skid contains a heat recovery unit, an electric heater, the thermal catalytic oxidizer, and the NO_x selective catalytic reducer. This room is designated as a C3 area.~~

~~2.4.11.5~~2.4.11.4 Canister Handling Cave, H-146

The canister handling cave is at the -3 ft level on the south side of the HLW facility (Figures 2A-1, 2A-4, 2A-7, 2A-8, and 2A-9). The cave is designated as a C5/R5 area with activities being performed using overhead cranes and master slave manipulators (MSM). The crane decontamination area, which can be isolated from the cave by a shield door, is on the west end. The crane maintenance area, which can be isolated from the crane decontamination area by a confinement door, is west of the crane decontamination area and is designated as a C3/R3 area. The following equipment is associated with the canister handling cave:

- Monorail (section 2.4.19)
- MSM (section 2.4.19)
- Robotic swabbing arm (section 2.4.19)
- Swab analyzing station (section 2.4.19)
- Waste monitoring station (section 2.4.19)

2.4.12.8 HLW Facility Annex, H-A101 through H-~~128~~~~122~~A121, A121, A126

The HLW facility annex will be attached to the main HLW facility at the west side (Figure 2A-2). The following annex areas are at grade level. Annex areas are designated either C2 or C1.

- Transformer/battery room
- UPS rooms
- Battery rooms
- Load center rooms
- Corridor
- Health physics rooms
- Personnel access rooms
- Facility control room
- Administrative or office areas

2.4.12.8.1 HLW Facility Annex, ~~Secondary Offgas Oxidizer and Activated Carbon Absorber~~ Room H-A123

Located at the south end of the Annex at grade level is the secondary offgas oxidizer and activated carbon ~~absorber~~column room (Figures 2A-2, and 2A-10~~9~~). The standby control room which did occupy this space was moved to pretreatment control room which is in a hardened facility. The catalyst skids are located in this room. The catalyst skid contains a heat recovery unit, an electric heater, the thermal catalytic oxidizer, and the NO_x selective catalytic reducer.

The sulfur-impregnated a~~A~~ctivated a~~C~~arbon c~~C~~olumns ~~for removing volatile mercury compounds from the offgas is also~~ are located in this room. ~~The AC Column consists of two sulfur impregnated activated charcoal beds that are about 2 m^3 each in volume.~~ This room is designated as a C3 area.

2.4.12.9 Miscellaneous 0 ft Level Areas

The following areas at grade level represent the remaining HLW 0 ft facility floor space. These C2 areas are:

- Corridors
- Subchange
- Shielded pipeways
- Operations support areas

2.5.2.4 Bubblers

Bubbling in the WTP melters increases the processing rate. The bubble gas is introduced into the molten glass pool using "bubblers." These are purpose-designed tubes mounted to the top of the melter and protruding through the surface of the molten glass, that release bubbles near the bottom of the glass pool. The bubbles rise in the molten glass, drawing the glass with them to the surface. This increases the transfer of heat from the molten glass to the cold cap, which in turn increases the rate at which the cold cap is converted to molten glass.

2.5.2.5 Glass Discharge

The glass level in the melter is maintained between the top of the electrodes and the overflow level of the discharge trough. The melter glass pool level will be measured to indicate when to start and stop glass discharge. Each melter has two independently operated glass discharge systems, adjacent to each other on one side of the melter. Each system includes an airlift riser, an airlift lance, a glass pour trough, and a heated discharge chamber. Glass is discharged by introducing gas into the molten glass in the discharge riser. The gas increases the level in the riser, causing the molten glass to flow down the trough and fall from the tip of the trough into the canister. When the desired level in the canister is reached, the air lift gas is turned off, and the glass level in the riser recedes stopping the flow of glass to the canister.

2.5.2.6 Glass Pour Spout

The glass pour spout connects the melter discharge chamber to the canister. The pour spout minimizes the spread of contamination from the glass pour stream and locates the canister directly under the tip of the pour trough. Instrumentation is provided to ensure that glass is not poured unless a container is present and properly located. The glass pour spout, and the canister when it is engaged, is ventilated through the discharge chamber to the offgas system. When the canister is not engaged, a melter pour spout drip tray moves to a closed position beneath the glass pour spout.

2.5.3 Melter Offgas Treatment Process System (HOP)

Offgas is generated from the vitrification of high-level waste in the melters. The offgas generation rate in the melter fluctuates. This offgas results from decomposition, oxidation, and vaporization of feed material. Constituents of the offgas include:

- Nitrogen oxides (NO_x) and carbon dioxide (CO_2) from decomposition of metal nitrates, nitrites, and carbonates in the melter feed
- Chlorine, fluorine, and sulfur as oxides, acid gases, and salts
- Cesium, strontium, technetium and minor concentrations of other radionuclides
- Small quantities of other, volatile radioactive compounds including ^{129}I, ^{14}C (in the form of CO_2), tritium (in the form of water), and volatile organic compounds
- <u>Mercury compounds</u>
- Air from in-leakage, bubblers (if used), instrumentation, and purges
- Steam from evaporation of melter feed water

The HLW offgas system cools and treats the melter offgas and vessel ventilation offgas to a level that meets the environment, safety, and health requirements.

The HLW offgas system is divided into the primary system and the secondary system to form the HOP (Figures 2A-29 and 2A-30). The primary offgas system is designed to handle dynamic changes in offgas generation rates. The primary system consists of a film cooler mounted on the melter, SBS, WESP, HEME, and HEPA air filters including a preheater. This system cools the offgas, condenses the steam, and removes particulates.

A standby line from the melter to the SBS is provided in case the function of the primary offgas line is impaired or melter gas generation exceeds the design basis of the primary line. This extra line is fitted with a valve as an isolation device, which is normally closed. If melter vacuum decreases to a set point, the valve is actuated and offgas flow is allowed through the line to the SBS, thereby increasing the system flow capacity from melter to SBS. If melter offgas is generated at a rate higher than the system is designed to handle, a vent acts at a pressure setpoint to vent the offgas into the melter cell. Once the melter pressure is below that value, the vent closes.

After the WESP, the vessel ventilation header is combined with the primary offgas treatment system for treatment. The vessel ventilation header receives offgas from the concentrate receipt process system vessels, melter feed process system vessels, and the radioactive waste handling vessels. The offgas received through the vessel ventilation system consists primarily of air, water vapor, and minor amounts of aerosols generated by the agitation or movement of vessel contents.

There are parallel HEME, preheater, and HEPA filter trains in the primary system. If a component fails in the primary train, offgas flow automatically transfers to the parallel train.

The secondary offgas system (after the HEPA filters to final discharge) removes hazardous gases including volatile mercury compounds, volatile organics, NO_x, and volatile halides including ^{129}I. The exhausters used to maintain the system under vacuum are also included as part of the system. The secondary offgas system consists of activated carbon and silver mordenite ~~absorbers~~columns, heat exchangers, a heater, exhausters, and ~~a~~ catalytic ~~oxidizer~~ units for the oxidation of volatile organic compounds ~~oxidation~~ and the reduction of oxides of nitrogen. Mercury compounds are removed by activated carbon. Treatment for iodine, ^{129}I, chloride and fluoride removal is with silver mordenite. The thermal oxidizer destroys volatile organics and a selective catalytic reduction, ~~A~~ SCR, unit reduces NO_x to nitrogen and water. ~~Final treatment of the offgas is by a silver mordenite column for volatile ^{129}I and chloride and fluoride removal~~. The offgas from the secondary offgas system is routed to the plant stack.

No maintenance on the SBS or WESP is planned between melter outages. However, prudent design mandates the capability to maintain these pieces of equipment between melter outages, if necessary. To do this, a maintenance bypass line is provided from the melter to downstream of the WESP. This bypass line would only be used when the melter was idled and the challenge to the offgas system is reduced to low levels. At this point, the maintenance bypass would be opened and the isolation valve downstream of the WESP closed.

The following sections detail the primary components of these offgas systems.

The HEME is a high efficiency demister with 99 % removal efficiency for aerosols down to submicron size. There is a water misting nozzle in the HEME gas inlet. The water mist facilitates self washing of solids from the filter element. As the offgas passes through the HEME, the liquid droplets and other aerosols collect on HEME filaments. The droplets agglomerate and flow by gravity to the bottom of the unit. The droplets are collected in the bottom of the HEME and drain into the SBS condensate receiver vessel. As condensate flows down through the filter bed, a washing action is generated that helps wash collected solids from the filter elements. Some solids may accumulate in the bed over time, causing the pressure drop across the filter to increase. When the pressure drop across the HEME reaches a predefined setting, it will be taken offline and washed or soaked with demineralized water to remove accumulated solids. Insoluble solids may remain, however, and their accumulation will eventually require replacing the HEME filter bed.

The HEME instrumentation, alarms, controls, and interlocks will indicate the following conditions:

- High differential pressure across the unit
- Low differential pressure across the unit
- Loss of water supply
- Retention of liquid

2.5.3.1.6 HEPA Preheaters and Filters

HEPA filters remove final particulates from the offgas. The combined offgas stream passes through the HLW melter offgas HEPA preheater, which increases the gas temperature above its dew point to avoid condensation in the HEPA filters. The offgas then passes through two sets of HEPA filters, arranged in series, to obtain ≥99.999 % removal efficiency of particulates. The system consists of two parallel trains of two filters each in series. The offgas passes through one train; the other is on standby.

HEPA unit instrumentation, alarms, controls, and interlocks will indicate the following conditions:

- High differential pressure across a HEPA, signaling a switch to the redundant unit
- Loss of preheater
- Low pressure differential
- High radiation in the outlet stream
- High radiation on the filters

2.5.3.2 HLW Secondary Offgas System

Major components in this system include exhaust fans, activated carbon ~~absorbers~~columns, heat exchangers, ~~exhaust fans,~~ silver mordenite column, and a skid with a thermal catalytic oxidizer and ~~/~~SCR ~~system~~unit ~~and silver mordenite column~~ (Figure 2A-30).

~~2.5.3.2.1Booster Fan Preheater~~

2.5.3.2.1 Exhauster Fans

The offgas from the ~~HEPA filters exits the filter cave~~primary booster fans is discharged into the secondary offgas system where the draft on the system is provided by the stack~~booster~~ extraction fans. Three variable speed primary booster extraction fans ~~downstream of the booster fan preheater (in a separate room)~~ provide the offgas motive force to keep the melter offgas system under vacuum. Each exhauster fan is rated at 50 % of the total system capacity. Two exhausters normally operate concurrently. Each exhauster fan has a nominal capacity of about 1,000 cfm at 60 in. w.g. ~~The exhaust offgas continues through the catalytic oxidizer/SCR unit.~~

An additional set of three variable speed stack extraction fans down stream of the silver mordenite preheater (in a separate room in the line to the stack) supports the booster extraction fans and maintain the secondary offgas treatment system under vacuum. Each exhauster fan is rated at 50 % of the total system capacity. Two exhausters normally operate concurrently. Each exhauster fan has a nominal capacity of 1,000 cfm at 60 in. w.g. The offgas then continues to the stack for exhaust to the atmosphere.

The third fan in each set is automatically activated on a fan failure. The fan power supply is backed up by emergency power. Fan instrumentation, alarms, controls, and interlocks will indicate the following conditions:

- Loss of fan power
- Low differential pressure across the fans
- High differential pressure across the fans
- Fans operating/switch
- High Secondary Offgas Pressure (Low Vacuum)

2.5.3.2.2 Activated Carbon (AC) ~~Column~~Column

The sulfur-impregnated Activated Carbon Column removes volatile mercury compounds from the offgas at a mildly elevated temperature. The AC Column consists of two sulfur-impregnated activated charcoal beds. ~~that are about 2 m^3 each in volume. Each bed is contained in a vessel that is approximately 8 ft by 8 ft by 7 ft long. The vessels are insulated.~~ The piping and valving are arranged to operate the beds in series (normal), in parallel, or individually. ~~Connections are provided on each vessel to load the AC through isolation valves.~~ A bypass line is manually activated bypassing the bed of spent activated carbon. Treatment of the melter offgas in the bypass mode continues by routing the offgas through the second bed in series. The system is contact maintained and the valve operations for gas and AC routing are performed by remotely actuated valves. ~~The vessels and associated piping are constructed of 316 L stainless steel.~~

An automatically activated, based on differential (inlet/exit) CO concentration, water deluge fire suppression system is provided for safety. The offgas inlet isolation valve is automatically closed on system activation. ~~A water overflow valve is automatically activated in each vessel in case of fire to prevent overfilling with water. A water drain system is also provided.~~

2.5.3.2.3 ~~Booster Fan~~Silver Mordenite ~~Preheater~~Heat Recovery Unit

The offgas from the primary offgas treatment system leaves the last primary treatment unit, ~~from~~ the HEPA filters, ~~exits the filter cave into~~ and enters the activated carbon beds in the secondary offgas system then, ~~and~~ passes through a heat exchanger to recover heat from the gas exiting the ~~silver mordenite column~~catalyst skid.

The heated offgas ~~reduces~~supplies -the heat input requirements for ~~organic oxidation and ensures that the offgas temperature is maintained above the due point to prevent condensation, which could erode fan blades.~~ the adsorption of iodine and the other halides on silver mordenite in the silver mordenite column. ~~The exit offgas flows to the booster extraction fans, and the silver mordenite offgas exits to the stack extraction fans.~~

The ~~booster fan~~silver mordenite preheater has pressure and temperature indication instrumentation. There are ~~no alarms, trips, or~~ controls to protect abnormal situations.

2.5.3.2.4 Silver Mordenite Column

The silver mordenite column is downstream of the ~~catalyst skid, after the offgas passes through catalyst skid~~silver mordenite ~~preheater~~heat recovery unit. The silver mordenite column removes ≥99.9 % of the ^{129}I from the melter offgas stream. The silver mordenite also absorbs volatile forms of chlorine and fluorine.

There is instrumentation provided for temperature and differential pressure monitoring. There are no controls, trips, or interlocks for the column operation. Halide and radiation monitors downstream of the column monitor for breakthrough, which would indicate the need for ~~column~~ replacement of the silver mordenite adsorbent.

2.5.3.2.5 Thermal Catalytic Oxidizer and Selective Catalytic Reduction, SCR

Because the melter decomposes the parent nitrate/nitrite compounds, the offgas contains NO_x. Offgas passing through the SBS will have part of the NO_x, removed. NO_x, removal will be completed in the SCR.

Volatile organic compounds are also present in the offgas stream and require removal. To meet these requirements, the offgas is passes through a catalytic oxidizer. A skid-mounted unit houses a heat recovery unit, an electric heater, the thermal catalytic oxidizer, and the SCR (i.e. catalyst skid).

As the offgas enters the unit, it passes through the heat recovery unit, which is a plate heat exchanger. The heating medium is the exhaust from the catalytic oxidizer/SCR unit. The offgas passes through the heat recovery exchanger and then through an electric heater to bring the temperature up to that required for the ~~volatile organic~~ catalyst to destroy the volatile organics. ~~operate~~

The volatile organic catalyst ~~column may~~ operates at a lower temperature than the NO_x catalyst, and is therefore placed first. The volatile organic destruction reaction is exothermic, providing heat to the offgas. Through this catalytic reaction, the organics are decomposed into carbon dioxide, and water vapor.

After going through the volatile organic catalyst, the offgas enters a chamber where ammonia gas is injected. Ammonia reacts with the NO_x in the presence of a catalyst and reduces it to nitrogen and water vapor~~ in the NO_x catalyst module~~. The NO_x destruction is about 95 %. The treated offgas stream ~~then goes through the heat exchanger and to the silver mordenite~~ is circulated through the heat recovery units and the silver mordenite column before being cooled by the evaporation of water injected into the offgas through a spray nozzle ~~column for removal of iodine and gaseous halide~~preheater for heat recovery.

The catalytic oxidizer/SCR unit instrumentation, and alarms~~, controls, and interlocks~~ will indicate abnormal conditions, including:

- Low Temperature
- High Temperature Protection
- Ammonia and NO_x analyzer over limit alarm indicating system malfunction
- High Discharge Temperature
- High volatile organic compound concentration in the unit outlet stream

2.5.4 Canister Handling Systems

The following sections describe the canister handling systems at the HLW vitrification facility (Figure 2A-31). Section 2.5.4.1 addresses clean canister import, section 2.5.4.2 addresses canister handling and buffer storage, section 2.5.4.3 addresses canister decontamination, swabbing and monitoring, and canister storage and export is addressed in section 2.5.4.4. Sections 2.4.1.11 and 2.4.1.12 describe the locations and systems. Section 2.4.5 discusses the mechanical handling equipment.

2.5.4.1 Clean Canister Import

The sequence of operations and the equipment used for canister import are as follows:

- The shipping crates are unloaded from the transport truck with an overhead crane and horizontal canister attachment (section 2.4.19) and placed in the staging area.
- The canisters are then individually removed from the shipping crate with dual horizontal grapples, and set on the canister inspection/rotation table. The lid is removed and both canister and lid are inspected. The lid is replaced and secured.
- The import bulge roller shutter door is opened and the table rotates the canister to vertical. The monorail hoist and grapple lift and transfer the canister to the canister import room. The canister is either set in the import buffer rack or placed in the import bogie. When the canister is transferred to the import tunnel, the sealed shielded hatch is opened and the canister is lowered into the canister import bogie below, and the hatch is closed and sealed.
- The bogie is transferred under the canister handling cave to the shielded hatch location. The canister handling cave shielded hatch is then opened and the canister handling cave crane and grapple raises the canister into the canister handling cave. The hatch is closed and the canister import bogie is returned to under the import bulge hatch.

3 Hazard and Accident Analyses

3.1 Introduction

This chapter summarizes the hazard and accident analysis methodology and presents detailed hazard characterization information and hazard and accident analysis results for the River Protection Project - Waste Treatment Plant (WTP) high-level waste (HLW) facility. The *Preliminary Safety Analysis Report to Support Partial Construction Authorization* (24590-WTP-PSAR-ESH-01-001), General Information volume, details the hazard and accident analysis methodology. The hazard and accident analyses in this volume evaluate the preliminary design and operation of the HLW vitrification facility. As the design matures, the hazards and accident analyses will be revised to reflect the final design.

The results of the hazard and accident analyses are used to identify the important to safety (ITS) structures, systems, and components (SSCs) and the technical safety requirements (TSRs) to protect the health and safety of the facility worker, co-located worker, and the public. Design features (for example, cell walls, floors, and ceiling) of the facility required to prevent uncontrolled releases of radioactive and hazardous materials are also identified.

3.2 Requirements

The principal requirements applicable to the HLW vitrification facility hazard and accident analyses are in section 3.2 of 24590-WTP-PSAR-ESH-01-001-01 (General Information).

3.3 Hazard Analysis

3.3.1 Hazard Identification

General Information, Chapter 3, describes the general requirements for hazard identification methodology. The HLW hazard analyses were conducted in phases, consistent with the developing design.

- The first phase was based on conceptual design material (draft system descriptions, process flow diagrams). The first phase used the preliminary hazards analysis technique (HAZOP-1). The preliminary hazards analysis was augmented with guide-words, as described in *Integrated Safety Management* (24590-WTP-GPG-SANA-002).
- The second phase, based on more definitive design material (Chapter 2 figures, Stage B P&IDs), forms the basis for this PSAR. The second phase used a HAZOP or other technique in accordance with 24590-WTP-GPG-SANA-002.
- The third phase was a HAZOP analysis performed on the Revision 1, P&IDs (Draft) of the primary and secondary HLW melter offgas system. The results of the HAZOP analysis are reported in 24590-HLW-SIN-ENS-03-003.

Application of the hazard analysis methodology in accordance with 24590-WTP-GPG-SANA-002 is provided in the individual system files prepared and maintained for the HLW facility safety analysis. The results of the hazard analysis are discussed in the following sections.

information is captured in CSD entries (Appendix A) and in the HLW melter offgas HAZOP deviations in the Attachment of the HLW Melter Offgas HAZOP Study (24590-HLW-SIN-ENS-03-003)~~entries uniquely identified by system and accident number (Appendix A)~~. For each Safety Case Requirement selected as safety design class (SDC) or safety design significant (SDS) ITS, SSCs and codes and standards are identified and recorded (Chapter 4). For each Safety Case Requirement selected as risk reduction class (RRC) SSCs are identified. The RRC SSCs and functions are listed in Table 3-9.

The HLW facility severity levels are documented in *Revised Severity Level Calculations for the HLW Facility* (24590-HLW-Z0C-W14T-00013). Calculations were performed for liquid spills, spray releases, canister and drum drops, molten glass spills, melter offgas releases, explosions due to hydrogen ignition, and impacts to HEPA filters (encased and unencased). The 24590-HLW-Z0C-W14T-00013 severity levels are based on the revised isotopic concentrations in 24590-PTF-M4C-V11T-00003, bounding release fractions, and maximum system volumes.

3.3.3.1 HLW Common Areas Hazard Evaluation Results

Appendix A contains the radiological, nuclear and process safety CSD records developed during the hazard evaluation for the HLW common areas. The HLW Melter Offgas HAZOP Study (24590-HLW-SIN-ENS-03-003) is a record of the most recent analysis. The following discussion highlights the major conclusions from Appendix A and the HLW Melter Offgas HAZOP Study.

Significant potential hazardous situations included the following:

- Fires in subchange rooms, workshops, or maintenance areas resulting in plugging and rupture of C5 or C3 high efficiency particulate air (HEPA) filters
- Criticality
- Failure of through-wall seals around shield doors, windows, and service penetrations
- Loss of C5 ventilation (due to loss of power or fan failure)
- Catastrophic failure of shield doors and windows (due to seismic event)

Fire-induced rupture of the HEPA filters results in SL-3 and SL-4 consequences to the co-located workers and the public, respectively. Failure of shielding results in SL-1 facility worker direct doses. Loss of the C5 ventilation flow results in SL-4 consequences to the co-located worker and public. Criticality in the HLW facility was deemed not credible (*Criticality Safety Evaluation Report for the RPP-WTP*, 24590-WTP-RPT-NS-01-001).

Identification of Control Strategies

Control strategies for minimizing the risk due to loss of a penetration seal include locating items in appropriately shielded areas and the Radiation Protection Program. In addition, the design will incorporate joggled paths for through-wall penetrations, minimizing radiation streaming. These SSCs will be seismically qualified, as appropriate, to prevent a catastrophic loss of shielding. Although not specifically required to meet exposure standards or SRD Appendix B defense-in-depth criteria, the following RRC control strategy for direct radiation has been identified: radiation monitoring of occupied areas with area radiation monitors (ARM) to indicate dose rates over established limits.

For potential loss of the C5 ventilation system, the control strategies include designing the structure to minimize outleakage into lower contamination areas and designing a reliable C5 ventilation system that maintaining the functional requirements of the SDC components that provide vessel agitation and purge, and designing vessels and their installed equipment to minimize ignition sources.

Control strategies to minimize the risk of increased aerosol generation in the vessels include the process vessel ventilation system (HEPA filtration). Although not specifically required to meet exposure standards or SRD Appendix B defense-in-depth criteria, the following RRC control strategy for aerosol generation in the vessels has been identified: radiation monitoring of occupied areas with continuous air monitors (CAM) will indicate loss of contamination from confinement.

Control strategies to minimize the risk of direct radiation exposure to facility workers include the shielding design, the joggled path of through-wall penetrations, and the Radiation Protection Program. Although not specifically required to meet exposure standards or SRD Appendix B defense-in-depth criteria, the following RRC control strategy for direct radiation has been identified: radiation monitoring of occupied areas to indicate excessive radiation (ARMs).

3.3.3.3 HLW Melter and Offgas Treatment Systems Hazard Evaluation Results

Appendix A and the HLW Melter Offgas HAZOP Study (24590-HLW-SIN-ENS-03-003) contains the radiological, nuclear, and process safety ~~CSD~~ records developed during the hazard evaluation for the HLW melter and offgas treatment systems. The melter processes highly radioactive liquid slurry. The resultant gases and molten glass are also highly radioactive, presenting internal and external radioactive dose concerns. Also, the melter draws large amounts of electrical current, generating a high heat condition resulting in electrical and thermal hazards. The following discussion highlights the major conclusions from Appendix A.

Of the events evaluated for the melter and melter offgas system, three were considered not credible. The first is igniting an explosive gas in the melter offgas stream due to an inconstancy in melter feed. This explosion was deemed not credible because the initiating event requires a four-fold increase in sugar, coincident with a 400 % surge in the offgas flow rate. A steam explosion in the melter caused by high water or direct injection in the glass melt was also considered not credible. To initiate a steam explosion, water would have to be injected into the high viscosity glass melt pool (40 - 50 poise). The current melter design does not allow for direct injection of water to the melt pool, and complete flooding of the melter (submersion of the melt pool) would not result in the required temperature. A second initiator for a steam explosion involves oil or water in the melter air stream. The air is heated as it is conveyed down the airline, and the oil and water will be in vapor form when it reaches the glass pool. This prevents the injection of liquid required to achieve the nucleate boiling leading to a steam explosion.

Credible hazardous situations include the following:

- Loss of offgas depression (due to loss of offsite power, replacing consumables during melter operation, plugging of the offgas system, failure of the offgas exhaust fan, or breach of the offgas duct due to impact with the crane)
- Pressurizing of the offgas system (due to excessive or inconsistent [such as high manganese dioxide] feed, buildup and subsequent collapse or reboil of the cold cap, excessive water in the slurry) resulting in offgas releases to the cell
- Release of glass from the melter (due to water hammer in the cooling jacket, loss of cooling to the melter, electrode failures, power cycling causing repeated heating and cooling, failure of melter level control overfilling the product canister, failure of the refractory, or seismic event)

- Release of contaminated condensate from the submerged bed scrubber (SBS)
- Damage to mercury column from localized 'hot spot' in activated carbon bed vents volatile mercury and sulfur dioxide into C3 Area

Events involving the release of offgas or molten glass result in SL-1 consequences to the facility and co-located workers and SL-2 consequences to the public. The worst spill from the SBS vessel results in SL-1 consequences to the facility worker, SL-3 consequences to the co-located worker, and SL-4 consequences to the public.

Identification of Control Strategies

Control strategies for minimizing the risk of a loss of offgas depression and subsequent release of offgas to the cell include the following:

- Administrative controls related to offgas and melter system operation
- Stopping feeds to the melter at a specified liquid level setpoint in the SBS or SBS condensate receiver vessel (prevents liquid level from reaching sufficient height to fail the offgas exhaust fan)
- Alarms at high differential pressure, maintaining a negative pressure in the offgas/vessel ventilation with respect to the C5 cell (fans are backed by emergency power)
- The C5 exhaust ventilation system

Control strategies for minimizing the risk of overpressurizing the melter and causing a subsequent release of offgas to the cell include the following:

- Stopping melter feed on high plenum pressure
- Stopping the injection of film cooler air in the event of high melter pressure or on activation of the standby line
- Alarms at high differential pressure
- The C5 exhaust ventilation system

Control strategies for minimizing the risk of melter confinement or glass pour failure and subsequent release of molten glass to the cell include the following:

- Design of the melter
- Reliable canister level measurement interlocked with the melter pour/airlift cycle
- Design of a melter pour spout drip tray that moves into position beneath the pour spout when a canister is not present
- Secondary confinement of the molten glass by the cell
- C5 exhaust ventilation system

Although not specifically required to meet exposure standards or SRD Appendix B defense-in-depth criteria, the following RRC control strategy has been identified for molten glass spills and offgas releases: cooling water to melter is provided by redundant pumps with backup power.

Control strategies for minimizing the risk of a 'hot spot' in the activated carbon media in the mercury column include:

- CO monitors on the inlet and outlet of mercury column to detect combustion products
- Water deluge activated by detection of high CO concentration at the outlet of the mercury column
- Isolation valves on the inlet to the bed

~~Although not specifically required to meet exposure standards or SRD Appendix B defense-in-depth criteria, the following RRC control strategy has been identified for molten glass spills and offgas releases: cooling water to melter is provided by redundant pumps with backup power.~~

Control strategies for minimizing the risk of SBS contaminated condensate releases include the following:

- Crane design that minimizes uncontrolled movement
- Piping integrity, SBS engineered overflows
- Stopping feeds to the melter at a specified liquid level in the SBS or SBS condensate receiver vessel
- Secondary confinement of the liquid by the cell
- C5 exhaust ventilation system

Although not specifically required to meet exposure standards or SRD Appendix B defense-in-depth criteria, the following RRC control strategy for liquid releases from the SBS has been identified: alarm on high/high liquid level to notify operators of abnormal conditions.

3.3.3.4 IHLW Canister and Canister Cask Handling Hazard Evaluation Results

Appendix A contains the radiological, nuclear, and process safety CSD records developed during the hazard evaluation of the immobilized high-level waste (IHLW) canister handling and storage area. The following discussion highlights the major conclusions from Appendix A.

The significant hazard associated with this system is the vitrified waste in the IHLW product canister. This material is a source of direct radiation and if dropped, is a potential source of respirable material.

Credible significant potential hazardous situations include the following:

- A canister or canister cask being dropped from a process crane or transfer bogie (due to crane/bogie failure, fire, or operator error)
- Direct radiation exposure (due to crane, bogie, or load impacts with shield doors, walls, or windows, personnel in a high radiation area, or from the significant levels of contamination generated during the canister process operations [such as glass pour, welding, decontamination])

Events involving the drop of IHLW canisters or canister casks result in SL-1 consequences to the facility and co-located workers and SL-3 consequences to the public. Events involving direct radiation result in SL-1 consequences to the facility worker.

Co-Located Worker and Public DBE Selection Process Summary

1 The CSD records are sorted to extract events with SL-1, SL-2, or above threshold consequences to either the co-located worker or public.

2 Events with SL-1, SL-2, or above threshold consequences to the co-located worker or public are then grouped by their Safety Case Requirements and accident type.

3 CSD entries in each group are then ranked by their radiological or chemical consequences.

4 The highest ranked CSD entries are selected as DBEs.

5 In some cases, final DBE selection relies on a qualitative evaluation of the initiators and hazardous situations (engineering judgement).

Facility Worker DBE Selection Process Summary

1 The CSD records are sorted to extract all events with SL-1, SL-2, or above threshold consequences to the facility worker.

2 Events with SL-1, SL-2, and above threshold consequences to the facility worker that have identical controls (Safety Case Requirements) *and* accident types as events selected as co-located worker and public DBEs are set aside.

3 Events with SL-1, SL-2, and above threshold consequences to the facility worker that have unique Safety Case Requirements *or* accident types are grouped by their Safety Case Requirement and accident type.

4 CSD entries in each group are then ranked by their radiological or chemical consequences.

5 The highest ranked CSD entries are candidates selected as DBEs.

6 In some cases, final DBE selection relies on a qualitative evaluation of the initiators and hazardous situations (engineering judgement).

3.4 Accident Analysis

This section summarizes accident results in the DBE selection report (24590-WTP-RPT-TE-01-002), including the HLW-specific analysis parameters (such as meteorological dispersion data, hazardous material inventories) and DBE analyses. The accident analysis methodology is in section 3.4 of the General Information volume. The feed to the HLW facility will be controlled by an interfacing control with the PT facility. This control will require that feed to the facility be sampled and analyzed to protect the radiological and chemical constituent assumptions analyzed in the DBEs.

The following sections summarize the analyses of the selected internal DBEs (section 3.4.1) and external DBEs including NPH events (section 3.4.2).

Section Number	**DBE**
3.4.1.1	Liquid Spills
3.4.1.2	Overflows
3.4.1.3	Spray Leaks
3.4.1.4	Molten Glass Spill
3.4.1.5	Fire in Sulfur-Impregnated Activated Carbon Bed
3.4.1.~~5~~6	Canister Drops

3.4.1.~~6~~7	Secondary Waste Container Drops
3.4.1.~~7~~8	Hydrogen Explosion
3.4.1.~~8~~9	Melter Offgas
3.4.1.~~9~~10	Fire
3.4.1.~~10~~11	Loss of Contamination Control
3.4.1.~~11~~12	Direct Radiation
3.4.1.~~12~~13	Chemical Hazards (Ammonia)
3.4.2.1	Design Basis Seismic Event
3.4.2.2	Other Natural Phenomena Hazards

3.4.1 Internal Design Basis Events

This section discusses events that are considered internally generated DBEs. For each analyzed DBE, unmitigated and mitigated scenario descriptions are provided. For the unmitigated event, the analyzed scenario, the potential consequences, and the initiating event frequency are discussed. Based on the potential consequences and initiating event frequency, target frequencies or preventive and mitigative systems reliability requirements are identified.

For the facility worker, if unaffected by the event, passive design features (such as cell walls, floors, and ceilings) are used in the unmitigated analysis to define a finite area for calculating aerosol concentrations associated with the release. For example, a liquid spill in a cell would be confined by the cell floor and walls up to any penetrations. These passive design features are identified as initial assumptions and as controls or design features. No credit is taken for facility holdup or plate out of radioactive materials.

For the mitigated event, crediting the selected control elements, the source term and estimated consequences to the facility worker, co-located worker, and the public are calculated. The estimated consequences are compared to the Radiological Exposure Standard (RES) Table (SRD Table 2-1) and Safety Criterion 2.0-2 (chemical) to determine the adequacy of the selected controls to ensure the health and safety of the facility worker, co-located worker, and the public.

The ITS barriers credited in the mitigated analyses are identified and assessed regarding their performance requirements for functioning in the operating environment that could be experienced during the DBE. Section 3.4.3 provides an assessment of the HLW facility operating environments and ITS SSC performance requirements.

After the mitigated DBE analysis is completed, the failure rates for the selected controls in conjunction with the initiating event frequency are compared to the target frequencies to determine the adequacy of the defense in depth of the controls (SRD, Appendix B). Following final selection of the mitigative or preventive controls, a summary is provided for the representative DBE, identifying the ITS SSCs, and preliminary safety category designations. Candidate TSRs required to ensure the ITS SSCs performance and additional programmatic controls required to mitigate or prevent the accident are identified.

3.4.1.1 Liquid Spills

Based on the results of the hazards analysis and DBE selection, the bounding or worst-case HLW facility liquid spill within the wet process cell is failure of a HLW concentrate receipt vessel. These vessels contain the most concentrated HLW process material (HLW feed concentrate from the HLW feed

(SRD, Volume II). Additional analyses are required to determine if the combined frequency (initiating event times failure rate of mitigative or preventive barriers) is less than 1.0E-06/yr. The following analyses evaluate the potential control's capability to meet the target frequency.

The controls selected to protect the facility worker are the canister high-high level interlock, cell boundary (initial assumption), and the C5 exhaust system ductwork and exhaust fans. The initiating event (molten glass spill due to canister overfill) frequency is 2.2E-03/yr (section 3.4.1.4.3.2). The calculated failure probability for the C5 exhaust fans (that is, failure to maintain cascade airflow) is 1.24E-05 (24590-HLW-U3C-C5V-00001). The combined frequency, molten glass spill due to canister overfill with loss of C5 exhaust fans, is 2.7E-08/yr, less than the target frequency of 1.0E-06/yr.

The controls selected to protect the co-located worker and public are the canister high-high level interlock, cell boundary (initial assumption), and the C5 exhaust system ductwork and HEPA filters.

Using the assumptions in the liquid spill scenario (that is, degraded HEPA filters), the probability of a rupture of one HEPA filter in the primary and one HEPA in the secondary bank of the same filter train is 2.5E-04. The LPF for this condition is 1.8E-03.

In conjunction with a molten glass spill due to canister overfill, a rupture of one HEPA in the primary and secondary HEPA filters banks was deemed not credible (5.5E-07/yr). However, if it did occur, the resultant doses are 8.3E-03 rem (co-located worker) and 1.4E-04 rem (public). Thus, the doses for the other (bounded) degraded HEPA filter conditions are below the limit of 25 rem for events of their frequency (SRD, Volume II, Appendix B).

3.4.1.4.3.7 Summary of ITS SSCs and Candidate Controls TSRs

Tables 4-1, 4-2, and 5-1 summarize the ITS SSCs and candidate TSRs, respectively, identified to prevent or mitigate molten glass spills. For each of the ITS SSCs and the candidate TSRs the hazard prevented or mitigated is identified and the safety function is provided.

3.4.1.5 Fire in Sulfur-Impregnated Activated Carbon Bed

The detailed discussion of this DBE and the data used in the~~and~~ analysis are~~is~~ found in ~~provided in~~ 24590-HLW-Z0C-30-00007. ~~Sulfur-impregnated activated carbon bed sorbs elemental mercury at sulfur active sites through chemisorption. All other speciated mercury as well as other compounds are sorbed by the bed through physiosorption. The bed is normally operated at temperatures that range from below 50 °C to below 100 °C. Vaporization and oxidation of the sulfur-impregnate occurs at above 100 °C (Nucon, 2000, Design and Performance Characteristics of MERSORB Mercury Absorbents, Bulletin 11B28, NUCON International Inc., Columbus, OH). At above 200 °C, removal efficiency of the bed becomes extremely poor. The ignition temperature of activated carbon is around 350 °C (CCN: 033851).~~

3.4.1.5.1 Unmitigated DBE Scenario Development

This section discusses the toxicological consequences of the unmitigated DBE scenario of a fire in the activated carbon column due to the conditions identified in the HLW melter offgas HAZOP study and reported in the following section. Inputs associated with this scenario are listed in the reference calculation, 24590-HLW-Z0C-30-00007, Rev. C. Accident environmental conditions for this event are a nominal flowrate of 1,736 CFM with a temperature of 157°F and 32.1% relative humidity. The offgas may contain up to 80 g/h of mercury with the nominal value being 10 g/h (24590-HLW-M6D-HOP-00001, Rev. A). Periodic flooding with water to extinguish fires in the carbon bed is anticipated.

Unmitigated DBE Scenario

A new DBE is created by the addition of a mercury column containing a medium of sulfur-impregnated activated carbon. The HLW melter offgas HAZOP study reviewed the mercury adsorber bed in its current location downstream of the primary booster fans (see 24590-HLW-SIN-ENS-03-003). The deviation generated from the guide word "High" and process parameter "Temperature" generated two causes: 1) Organics in offgas cause localized high temperature in bed, and 2) High relative humidity causes sulfur vaporization due to localized heating. For the deviation generated by the guide word "Low" and the process parameter, "Temperature", the HAZOP team generated two more deviations: 1) Operator error - failure to initiate startup heater sequence causes localized heating due to moisture on fresh activated carbon, and 2) Failure of HEPA pre-heater causes localized heating (hot spots) due to moisture on fresh activated carbon. The guide word "No" and the process parameter "Flow" resulted in five additional fire scenarios. The initiators are plugged bed, deposition of ammonium nitrate, operator error - valve misalignment, valve failure - equipment failure and attrition of bed. The consequences of these events are loss of offgas flow and possible fire due to no flow. Leaks into a C3 area, a HAZOP deviation in the mercury adsorber worksheet, are caused by localized hot spots from the previously mentioned events and this localized hot spot causes structural damage.

Unmitigated DBE Frequency

The initiating event frequency is expected to be in the "Anticipated" range.

3.4.1.5.2 Mitigated DBE Scenario

The following describes the mitigated DBE evaluation, including the initial control strategy, source term and consequence estimates and comparison to the ERPGs. Also identified are the credited preventative and mitigative features, and defense-in-depth engineered or administrative barriers.

Initial Control Strategy Selection

The controls that reduce the risk associated with a fire in the sulfur-impregnated activated carbon bed (Node HOP-N34 in the HLW Melter Offgas HAZOP Study, 24590-HLW-SIN-03-003) are:

a The valves and the offgas piping to the two beds of activated carbon bed are configured to isolate and bypass one or both beds. Isolating the system allows the oxygen in the bed to burn out.
b Carbon monoxide monitors provide a rapid response if combustion is occurring in a bed.
c Flooding the system with water.
d Temperature indication at the inlet and outlet of each bed.

Control strategy element "a", the sealing of a bed, is one alternative for fire suppression, the other, control strategy element "c", is flooding of the bed with water.

Means of fire detection are control strategy element "b", carbon monoxide monitors and control strategy element "d" temperature indication at inlet and outlet or the activated carbon beds.

Mitigated DBE Frequency

Although mitigative controls will be in place, they do not affect the frequency estimate provided in SIPD. Thus, the frequency of the accident sequence is the same as that of the initiating event, or "Anticipated".

3.4.1.5.3 Source Term Analysis

~~The source term for the fire in the sulfur-impregnated activated carbon volatilizes mercury that enters the C3 Area ventilation. Ventilation air flowing through the HLW Annex is the vector for mercury leaving the building and entering the environment through the C3 stack. Further air treatment is bypassed. The following design data is used as initial input to the DBE analysis:~~

- ~~With no mercury abatement, mercury feed rate in the vapor phase at contract maximum concentrations are 1.92 Kg per day or 0.08 Kg per hour (Cramer, et al, Mercury Abatement Technology Assessment for the WTP, 2001)~~
- ~~A release rate of 1 Kg per hour of the 480 Kg of mercury loaded on the bed, and~~
- ~~A release rate of 10 Kg per hour~~

~~Assume that the offgas is delivered out of confinement, and postulate the ground level release: Section 3.1.4 of 24590-WTP-GPG-SANA-004 describes the method for calculating the concentration of a contaminant at the receptor's location.~~

$$\cancel{C_A = QR \times \frac{\chi}{Q}}$$

~~Where:~~

~~C_A = steady-state air concentration of contaminant at the receptor (mg/m^3)~~
~~QR = release rate of aerosol, gas or vapor (mg/s)~~
~~χ/Q = atmospheric dispersion coefficient (s/m^3)~~

The unmitigated source term for this fire is calculated based on the maximum possible sustained rate of combustion of the sulfur-activated carbon bed. The available oxygen supply is (6,067 lb/hr) x (0.215) or 1,304.4 lb/hr (see Section 3.4.1.5). Based on data from a major vendor of adsorbent media, sulfur-impregnated activated carbon appropriate for mercury removal is expected to have a sulfur content of about 10% with the balance of the active material (90%) being carbon.

Because the adsorption medium is an intimate mixture of carbon (atomic weight 12.01) and sulfur (atomic weight 32.06) it is expected that each will burn and consume oxygen in proportion to its atomic abundance. The available oxygen will combine with the carbon and sulfur to yield carbon dioxide and sulfur dioxide, as follows:

$$C + O_2 \rightarrow CO_2$$
$$S + O_2 \rightarrow SO_2$$

The average atomic weight of the combustible carbon-sulfur mixture in the adsorption medium is (0.9)(12.01) + (0.1)(32.06) or 14.02. Therefore, for each pound-mole of available oxygen (32.00 lb), one equivalent pound-mole (14.02 lb) of the carbon-sulfur mixture will be consumed.

The amount of carbon-sulfur mixture that can be burned by the available oxygen supply is:

(1,304.4 lb/hr)(14.02 lb/lb-mole ÷ 32.00 lb/lb-mole) = 571.5 lb C-S/hr.

The theoretical equilibrium absorption capacity of one leading vendor's adsorption medium is reported to be 85 g of mercury per 100 g of adsorbent (see Attachment 2), but a very long service time would be necessary to achieve this level of loading. More likely values are on the order of 1/4 to 1/3 of the theoretical maximum. For this bounding case, the theoretical maximum mercury loading mass ratio (0.85) is used. The coal-derived activated carbon used for mercury adsorbent will typically contain eight to ten percent ash (CCN 033851). Therefore, the actual rate at which the complete "adsorption medium" is consumed by combustion will be about ten percent greater than the rate at which the carbon-sulfur mixture is calculated to be burned by the available oxygen supply. Accordingly, the rate at which the "adsorption medium" is consumed is:

(571.5 lb C-S/hr)(1.1 lb adsorption medium/lb C-S) = 628.7 lb adsorption medium/hr

The resulting rate of mercury release will be:

(628.7 lb adsorption medium/hr)(0.85 lb Hg/lb adsorption medium) = 534.4 lb/hr

Of the 571.5 lb/hr of carbon-sulfur mixture consumed, 10% (57.15 lb/hr) is sulfur. For each pound-mole of sulfur (32.06 lbs) consumed, one pound-mole of sulfur dioxide (64.06 lbs) will be produced. The resulting rate of sulfur dioxide release will be:

(57.15 lb/hr)(64.06 lb/lb-mole ÷ 32.06 lb/lb-mole) or 114.2 lb/hr of sulfur dioxide.

3.4.1.5.4 Consequence Analysis

Unmitigated Co-Located Worker and Public Dose Consequences

~~The atmospheric dispersion coefficient for the co-located worker's location, 100 m from the release, is 0.0341 s/m³ (24590-WTP-GPG-SANA-004). This is the worst-case sector specific dispersion coefficient calculated using 99.5 % Hanford site meteorology. The calculation of this dispersion coefficient postulated a ground level release with no credit for plume meander or building wake effects.~~

$$\cancel{C_{Hg} = \frac{0.08kg}{hr} \times \frac{hr}{3600s} \times \frac{10^6 mg}{kg} \times 0.0341 \frac{s}{m^3} = 0.758 \frac{mg}{m^3}}$$

~~0.758 mg/m³ is well above TEEL-2 concentrations of 0.1 mg/m³ for the co-located worker and only approximately a factor of ten below the TEEL-3 concentrations of 10 mg/m³. In other words, even if approximately 1 Kg of the 480 Kg of mercury is released per hour, concentrations at the co-located worker's location will exceed TEEL-3 concentrations of 10 mg/m³. Analogously, another factor of ten increase in the release rates will place public receptor's concentrations at above threshold (above TEEL-2 concentrations of 0.1 mg/m³).~~

Using bounding atmospheric dispersion factors (point source release, duration less than one hour, no consideration of plume meander or building wake), the concentrations of both mercury and sulfur dioxide at the public and co-located worker receptor locations are calculated in accordance with section 3.3 of 24590-WTP-GPG-SANA-004.

Mercury

Co-located Worker: (534.4 lb/hr)(4.536E+5 mg/lb)(1 hr/3,600 s)(3.41E-2 s/m^3) = 2.30E+3 mg/m^3

Public: (534.4 lb/hr)(4.536E+5 mg/lb)(1 hr/3,600 s)(2.43E-5 s/m^3) = 1.64 mg/m^3

As specified in section 3.2 of 24590-WTP-GPG-SANA-004, the applicable consequence threshold for the co-located worker is the ERPG-3 (AIHA, 2001) or TEEL-3 (WSMS, 2001) value, if ERPGs have not been established for the substance. The TEEL-3 value for mercury is 10 mg/m^3. The unmitigated consequences of this mercury release exceed the specified consequence threshold by more than two orders of magnitude. The event is therefore designated "Above Threshold" (AT). The applicable consequence threshold for the public receptor is the ERPG-2 (or TEEL-2) value of 0.1 mg/m^3. The public consequences of this mercury release also substantially exceed the specified consequence threshold.

Sulfur Dioxide

Co-located Worker: (114.2 lb/hr)(4.536E+5 mg/lb)(1 hr/3600 s)(3.41E-2 s/m^3) = 4.91E+2 mg/m^3

Public: (114.2 lb/hr)(4.536E+5 mg/lb)(1 hr/3600 s)(2.43E-5 s/m^3) = 0.350 mg/m^3

The ERPG-3 value for sulfur dioxide is 15 ppm (39.2 mg/m^3). The unmitigated consequences of this sulfur dioxide release exceed the specified consequence threshold by more than an order of magnitude. The event is therefore designated "Above Threshold" (AT). The public consequences of the SO_2 release do not exceed the specified consequence threshold (ERPG-2 value) of 3 ppm (7.8 mg/ m^3).

Mitigated Co-Located Worker ~~and Public~~ Dose Consequences

~~Section 3.4.1.5.2.1 is a list of potential ITS barriers to mitigate fires in the activated carbon media of the mercury column. The carbon monoxide monitors are the key components in preventing the release from reaching unmitigated levels. The Thermo Electron Corporation manufactures a carbon monoxide monitor with a range of 0 to 500 ppm (vol.). The detection of an increase in the carbon monoxide concentration of 100 ppm will release a small quantity of mercury before the bed is isolated and the deluge system actuated and the fire extinguished. A mercury monitor, a non-ITS component, will detect mercury volatilized by the in-bed combustion. For the 100 ppm actuation level, the quantity is estimated as follows: The normal operating flow through the activated carbon beds is 2039 cfm at 74 °C (24590-HLW-SIN-03-003). The vacuum in the activated carbon column is assumed to be –15 w.c. The volumetric flow rate of carbon monoxide is~~

$$\cancel{Q_{CO} = 2039 \frac{ft^3}{\min} x \frac{100}{1.0x10^6} x \frac{m^3}{35.314 ft^3}}$$

$$\cancel{Q_{CO} = 5.774x10^{-3} m^3 CO/\min}$$

~~The amount of carbon released as carbon monoxide is directly related to the amount of mercury released because the activated carbon is impregnated with sulfur and the mercury chemisorption takes place at the sulfur sites. From the moles of carbon monoxide released per minute, at a concentration of 100 ppm, the quantity of carbon, sulfur and mercury is determined. From the volume of carbon monoxide calculated at the temperature and pressure of the mercury column, the moles of carbon monoxide can be estimated from the Ideal Gas Law. The temperature in degrees Kelvin:~~

$$\cancel{T = 273.15 + 74}$$
$$\cancel{T = 347.15^oK}$$

~~The mercury column is under a slight vacuum of approximately 15 inches of water. Converting to a absolute pressure in SI units:~~

$$\cancel{P = 1.013x10^5 Pa - \frac{15inH_2O}{1} x248.14 \frac{Pa}{inH_2O}}$$
$$\cancel{P = 9.76x10^4 Pa}$$

~~For each gram-atomic weight of carbon consumed in the fire it produces one gram-molecular weight of carbon monoxide. The moles of carbon monoxide determined from the ideal gas law is equivalent to moles of carbon which is converted to mass of carbon by the carbon's gram-atomic weight (12.01).~~

$$\cancel{m_C = \frac{PV}{RT} 12.01}$$
$$\cancel{m_C = 2.345 \frac{gC}{\min}}$$

~~where,~~

$$\cancel{R = 8.3143 \frac{J}{Mol^OK}}$$

~~The activated carbon is impregnated with sulfur and the mercury is removed from the melter offgas by chemisorption at the sulfur-impregnated sites on the activated carbon. The mercury forms mercuric sulfide, HgS. The quantity of mercury released depends on the burned sulfur site containing mercury. If all sulfur-impregnated sites have combined mercury then the amount of mercury being released is estimated from the combining ratio of mercury with sulfur to form mercury sulphide. Sulfur-impregnated activated carbon is 10 % sulfur; the mass of sulfur,~~ $\cancel{m_S}$~~, combined with the carbon is,~~

$$\cancel{m_S = \frac{m_{AC}}{0.90} - m_{AC}}$$
$$\cancel{m_S = 0.261 gS/\min}$$

~~For the combining ratio of mercury sulfide, the atomic gram equivalents of sulfur is equivalent to the gram equivalents of mercury. Then the conversion from gram equivalent of mercury to mass of mercury is by the atomic weight of mercury. The mercury released at the 100 ppm carbon monoxide level is,~~

$$\cancel{m_{Hg} = \frac{0.261 gS/\min}{32.06} 200.59}$$

$$\cancel{m_{Hg} = 1.63 gHg/\min}$$

~~Actuation of the isolation valves and quenching the activated carbon with water from the deluge system pre-empts a runaway combustion when the carbon monoxide monitor detects a concentration of carbon monoxide of 100 ppm. The affect on the co-located worker, 100 meters from an unconfined release is~~

$$\cancel{C_{Hg} = \frac{1.63 gHg}{\min} \times \frac{\min}{60s} \times \frac{10^3 mg}{g} \times 0.0341 \frac{s}{m^3} = 0.926 \frac{mg}{m^3}}$$

~~For the co-located worker the concentration is above the TEEL-2 level of 0.1 mg/m^3 but approximately a factor of 10 below TEEL-3 level of 10.0 mg/m^3.~~

From the unmitigated consequence analysis, the mercury exposure to the co-located worker receptor exceeds the applicable threshold by the greatest amount and is therefore limiting. If that exposure criterion is met, the other consequence thresholds will not be exceeded.

In order to meet Safety Criterion (SC) 2.0-2 (24590-WTP-SRD-ESH-01-001-02) the release must be mitigated such that the maximum 10-minute average concentration at the receptor locations do not exceed the applicable thresholds. Mitigation first requires detection of the fire, followed by isolation of the bed and/or quenching the fire (inerting or flooding) to terminate the release. Details of the bed construction, adsorption media characteristics, sensitivity and response time of detectors, and other parameters needed to quantitatively model the performance of the selected control strategy have not been defined. Therefore, this analysis establishes the maximum 10-minute average release rate of mercury from the adsorber bed that will keep all receptor consequences "Below Threshold".

SC 2.0-2 will be satisfied if the highest 10-minute average release rate, multiplied by the limiting CLW dispersion coefficient is less than the applicable concentration threshold, as follows:

$(S/600)(\chi/Q) \leq T$

Where:

S	= Quantity released in any 10 minute period, mg
600	= 10 minutes x 60 s/minute, s
χ/Q	= Limiting CLW dispersion coefficient, sm^3
T	= Applicable concentration threshold, mg/m^3

Rearranging terms, the maximum 10 minute release that will meet the SC 2.0-2 consequence threshold is:

$S = (T \times 600\ s) \div (\chi/Q)$

As noted earlier in this section, the applicable CLW consequence threshold is 10 mg/m^3. As specified in section 3.4.2 of 24590-WTP-GPG-SANA-004, the appropriate dispersion coefficient for the mitigated consequence analysis is 1.14E-2 s/m^3 (point source, duration less than one hour, plume dissipated by nearby structures).

Therefore, the maximum allowable mercury release for any ten minute period is:

$S_{max} = \{(10 \text{ mg/ m}^3)(600 \text{ sec})\} \div (1.14\text{E-2 s/m}^3) = 5.26\text{E+5 mg, or } 526 \text{ g}$

As shown in section 7.3.2, 114.2 lb/hr of SO_2 will be released for each 534.4 lb/hr of mercury. Accordingly, the 10 minute SO_2 release corresponding to release of 526 g of mercury is:

(526 g)(114.2/534.4) = 112 g

Averaged over 10 minutes the release rate is 112 g ÷ 600 s or 0.187 g/s.

The concentration at the CLW location is (0.187 g/s)(1.14E-2 s/m^3) or 2.13E-3 g/m^3 (2.13 mg/m^3), compared to the consequence threshold of 39.2 mg/m^3.

Mitigated Public Dose Consequences

Using the appropriate public receptor dispersion coefficient of 2.27E-5 s/m^3 (point source, duration less than one hour, plume dissipated by nearby structures), the concentration of mercury at the public receptor corresponding to a mitigated mercury release rate of 526 g in 10 minutes is (526 g ÷ 600 s)(2.27E-5 s/m^3) or 1.99E-5 g/m^3 (1.99E-2 mg/m^3) compared to the consequence criterion of 0.1 mg/m^3.

As calculated above for the CLW, the SO_2 release rate corresponding to the mitigated mercury release rate is 0.187 g/s. The concentration at the public receptor is (0.187 g/s)(2.27E-5 s/m^3) or 4.24E-6 g/m^3 (4.24E--3 mg/m^3) compared to the consequence criterion of 7.8 mg/m^3.

If the performance of the fire detection/isolation/quench strategy is such that less than 526 g of mercury is released from an adsorber bed in any 10 minute period, the public consequences from both the mercury and concurrent SO_2 release will be significantly "Below Threshold" (BT).

Mitigated Facility Worker Dose Consequences

One aspect of the selected control strategy is isolation of the adsorber bed to exclude oxygen from the fire. Closing the inlet valve will effectively establish a high-integrity gas-tight barrier between the fire and the facility worker environment. As with all facility fire events, exposure of workers to heat, flames, combustion products, toxic emissions and radiological hazards is managed in accordance with the worker Health and Safety and Emergency Management programs.

~~3.4.1.5.5Final Control Strategy Selection~~

~~The mitigated analysis credited a subset of the potential ITS barriers (section 3.4.1.5.2.1) to prevent or mitigate the occurrence of combustion in the activated carbon used for adsorption of mercury. Tables 4-1 and 4-2 identify the systems, components, and their ITS designations. The tables also reference to Chapter 4 discussions regarding functional requirements, standards, and system evaluation. Table 3-23 provides operating environments for performance requirements beyond those required for normal operations. The capability of these barriers to perform their credited preventive or mitigative function (that is, treat toxic gases, confine liquids or aerosols, filter releases before discharge to the environment,~~

~~and place and maintain the facility in a safe state) is protected as design features or with TSRs. The ITS barriers credited in the mitigated analysis are shown below:~~

~~Carbon monoxide monitors~~

~~Isolation valves~~

~~Deluge system~~

Uncertainties and Conservatisms

MAR

For purposes of this analysis, mercury loading on the adsorption bed was assumed to be at the theoretical maximum value. This condition would be expected only late in the bed service life and in regions of the bed nearer the inlet face, with the rest of the bed having a lower, but indeterminate, volumetric mercury loading.

Release Rate/Fraction

The unbounded release rate was calculated as though all the oxygen in the inlet air stream was being consumed by the fire. In practice, carbon bed fires develop as hot spots that spread fairly slowly in the bed medium. Until the fire spreads to completely involve the cross sectional area of the bed (transverse to the direction of flow), a large part of the inlet air will pass through non-burning sections of the bed and not contribute to the combustion rate and the resulting mercury release.

Leak Path Factor

Each atom of mercury released from the fire was modeled as exiting the bed and entering the environment. In fact, much of the mercury released in a burning area would be expected to be trapped in sites deeper in the bed, then released again as the fire front advances. If the fire is detected based on carbon monoxide generation and the isolation/quench strategy is effective, it is possible that little or no mercury will actually exit the bed into the exhaust stream.

Atmospheric Dispersion Factors

The CLW and public atmospheric dispersion factors used in the analysis are very conservative, corresponding to 99.5% percentile adverse (stable) meteorological conditions concurrent with the accident.

3.4.1.5.5 Comparison to Exposure Standards

The chemical hazard exposure standards are provided as Safety Criterion 2.0-2 of the Safety Requirements Document (24590-WTP-SRD-ESH-01-001-02). The exposure standards are not related to estimated event frequency. For the CLW, the specified standard is the concentration equal to the 2001 ERPG-3 (or TEEL-3 value if no ERPG has been established). For the public receptor, the standard is the ERPG (or TEEL) –2 value. Section 3.2 of 24590-WTP-GPG-SANA-004 specifies that the exposure standard is to be compared to the highest predicted 10-minute average concentration of the substance at the receptor location. This DBE analysis establishes an integrated performance requirement for the selected control strategy (fire detection/isolation/suppression) that will assure compliance with SC 2.0-2. The results summarized are:

Receptor	Frequency of Occurrence	SC 2.0-2 Standard (mg/m^3)		Calculated Concentration (mg/m^3)*	
		Mercury	Sulfur Dioxide	Mercury	Sulfur Dioxide
Public	N/A	0.1	7.8	1.99E-2	4.24E-3
Co-located worker	N/A	10	39.2	$\leq$10*	2.13

* Mitigated consequences are based on integrated control strategy performance that limits mercury release to less than 526 g in any 10 minute period.

3.4.1.5.6 Final Control Strategy Selection

The mitigated analysis credited a subset of the potential ITS barriers (section 3.4.1.5.2.1) to prevent or mitigate the occurrence of combustion in the activated carbon used for adsorption of mercury. Tables 4-1 and 4-2 identify the systems, components, and their ITS designations. The tables also reference to Chapter 4 discussions regarding functional requirements, standards, and system evaluation. Table 3-23 provides operating environments for performance requirements beyond those required for normal operations. The capability of these barriers to perform their credited preventive or mitigative function (that is, treat toxic gases, confine liquids or aerosols, filter releases before discharge to the environment, and place and maintain the facility in a safe state) is protected as design features or with TSRs. The ITS barriers credited in the mitigated analysis are shown below:

- Carbon monoxide monitors
- Isolation valves on the inlet to the activated carbon beds
- Deluge system

The results of the mitigated consequence analysis indicate that the integrated performance of the detection/isolation/quench strategy must ensure that less than 526 grams of mercury is released from the adsorber bed in any 10 minute period.

3.4.1.5.7 Summary of ITS SSCs and Candidate Controls TSRs

Tables 4-1, 4-2, and 5-1 summarize the ITS SSCs and candidate TSRs, respectively, identified to mitigate a fire in the activated carbon beds. For each of the ITS SSCs and the candidate TSRs, the hazard prevented or mitigated is identified and the safety function is provided.

3.4.1.6 Canister Drops

A canister drop can be caused by bogie upsets and crane failures, rope failures, hook failures, grapple failures, controller failures, or operator errors. A dropped canister can result in the release of IHLW to occupied areas and the environment.

There are three representative DBEs for canister drops (24590-WTP-RPT-TE-01-002). These are a crane drop of an unlidded canister in a C5 area (CSD-HHPH/N0015), a crane drop of a canister in a C3 area (CSD-HHEH/N0013), and a crane drop of the canister export cask in a C2 area (CSD-HHEH/N0014). The DBE analyses determined that these three events adequately bound other drops selected as potential DBEs in 24590-WTP-RPT-TE-01-002. Therefore, unique controls associated with other drop events are

DOE STD 1027-92, Change Notice 1, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*. US Department of Energy, Washington, DC.

DOE/RL-2000-08, *Regulatory Unit Position on Conformance with Risk Goals in DOE/RL-96-0006.* US Department of Energy/Office of River Protection, Richland, Washington.

DOE/RL-2000-15, *Regulatory Unit Position on the Achievement of Adequate Safety*. US Department of Energy/Office of River Protection, Richland, Washington.

EPA 550-B-99-009, *Risk Management Program Guidance for Offsite Consequence Analysis*. US Environmental Protection Agency, Washington, DC.

NFPA 69. *Standard on Explosion Prevention Systems*. National Fire Protection Association, Quincy, Massachusetts.

NUREG/CR-6410, *Nuclear Fuel Cycle Facility Accident Analysis Handbook*. US Nuclear Regulatory Commission, Washington, DC.

RPP-5993. *River Protection Project Key Planning Assumptions*. US Department of Energy, PIO Administration, Project Integration Office, Richland, Washington.

Swain AD and Guttmann HE. 1983. *Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications*. NUREG/CR-1278 N, US Nuclear Regulatory Commission, Washington, DC.

WSMS, 2001. ERPGs and TEELs for Chemicals of Concern: Rev 17m, WSMS-SAE-00-0266, Westinghouse Safety Management Solutions, Aiken, SC.

Table 3-4 Hazardous Characteristics of HLW Process Chemicals and Potential Byproducts

Process Chemical/ Byproduct[a]	Exposure Pathway	IDLH[b]	TWA/PEL[c]	Flammable/ Explosive	Oxidizer	Corrosive	Notes
Mercury (II) Sulphide	inhalation, ingestion, skin/eye	0.1 mg/m3	0.025 mg/ m3 (ACGIH)	Noncombustible solid	No	No	Prolonged or repeated exposure may cause adverse reproductive effects. May cause kidney injury. Chronic exposure to mercury may cause permanent central nervous system damage, fatigue, weight loss, tremors, personality changes.
Nitric Acid	inhalation, ingestion, skin/eye	25 ppm	2 ppm (O)	Noncombustible liquid, increase the flammability of flammable materials	No	Yes	Contact with other material may cause fire. Liquid and mist cause severe burns to all body tissue. May be fatal if swallowed. Harmful if inhaled.
Radiolytic Hydrogen	inhalation	NE	NE	Flammable gas in mixtures with air	No	No	Asphyxiant
Silica, crystalline (cristobalite) (BOD)	inhalation, skin/eye	25 mg/m^3	5 mg/m^3/ (%SiO_2 + 2) (O)	Noncombustible solid	No	No	Prolonged exposure to respirable silica may cause delayed lung injury. Silica quartz is carcinogenic.
Silver mordenite	inhalation, skin/eye	NE	NE	No	No	No	Characterized as a zeolite in literature. In dry form may have same impact as nuisance dust
Sodium Hydroxide	inhalation, ingestion, skin/eye	10 mg/m^3	2 mg/m^3 (O)	Noncombustible solid, when in contact with water may generate sufficient heat to ignite combustible material	Yes	Yes	Corrosive irritant to eyes, mucous membrane, respiratory system, mouth, throat, and stomach. Can cause permanent damage to eye tissue, blindness

Table 3-4 Hazardous Characteristics of HLW Process Chemicals and Potential Byproducts

Process Chemical/ Byproduct[a]	Exposure Pathway	IDLH[b]	TWA/PEL[c]	Flammable/ Explosive	Oxidizer	Corrosive	Notes
Sucrose	inhalation, skin/eye	ND	15 mg/m^3 (total) 5 mg/m^3 (resp) (O)	Noncombustible solid, fine dust may explode	No	No	Nuisance dust
Sulfur-Impregnated Activated Carbon	inhalation/eye	NE	NE	All carbonaceous material will burn under certain conditions and activated carbon is not an exception	No	No	Acute toxic effects are not likely to develop after inhalation from this material. Prolonged inhalation may cause irritation of the mucous membranes
Titanium Dioxide	inhalation, skin/eye	5,000 mg/m^3	15 mg/m^3 (O)	Noncombustible solid	No	No	Prolonged or repeated contact may cause skin/eye irritation. Dust may cause irritation to upper respiratory tract and mucous membrane
Zinc Oxide (BOD)	inhalation	500 mg/m^3	5 mg/m^3 (resp dust) 15 mg/m^3 (total dust) 5 mg/m^3 (fume) (O)	Noncombustible solid	No	No	Repeated or prolonged contact with skin may cause dermatitis. Repeated or prolonged exposure may cause asthma.

Table 3-5 Chemical Interaction Table of HLW Process Chemicals

Chemicals and Potentially Hazardous Products	Aluminum Silicate (Al_2SiO_4)	Boric Acid (H_3BO_3)	Calcium Silicate ($CaSiO_3$)	Cerium (Ce^{4+})	Ferric Oxide (Fe_2O_3)	Hydrogen Peroxide (H_2O_2)	Lithium Carbonate	Magnesium Silicate (Mg_2SiO_4)	Mercury Sufide	Nitric Acid (HNO_3)	Radiolytic Hydrogen	Silica (SO_2)	Silver mordenite	Sodium Hydroxide (NaOH)	Sucrose (C12H22O11)	Sulfur-Impregnated Carbon	Titanium Oxide (TiO_2)	Zinc Oxide (ZnO)	Zircon Sand ($ZrSiO_4$)
Ammonia (NH_3)		NR	NR	NR	NR	NR	NR	NR	(9)	(8)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Aluminum Silicate (Al_2SiO_4)		NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Boric Acid (H_3BO_3)			NR	NR	NR	NR	x(1)	NR	NR	NR	NR	NR	NR	(2)	NR	NR	NR	NR	NR
Calcium Silicate ($CaSiO_3$)				NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium (Ce^{4+})					NR	(3)	(1)	NR	NR	NR	(4)	NR	NR	(2)	(5)	~~(5)~~NR	NR	NR	NR
Ferric Oxide (Fe_2O_3)						NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Hydrogen Peroxide (H_2O_2)							NR	NR	(10)	NR	(4)	NR	NR	NR	(6)	(6)	NR	NR	NR
Lithium Carbonate (Li_2CO_3)								NR	NR	(1)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Magnesium Silicate (Mg_2SiO_4)									NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Mercury Sulphide										(10)	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 3-5 Chemical Interaction Table of HLW Process Chemicals

Chemicals and Potentially Hazardous Products	Aluminum Silicate (Al_2SiO_4)	Boric Acid (H_3BO_3)	Calcium Silicate ($CaSiO_3$)	Cerium (Ce^{+4})	Ferric Oxide (Fe_2O_3)	Hydrogen Peroxide (H_2O_2)	Lithium Carbonate	Magnesium Silicate (Mg_2SiO_4)	Mercury Sufide	Nitric Acid (HNO_3)	Radiolytic Hydrogen	Silica (SO_2)	Silver mordenite	Sodium Hydroxide (NaOH)	Sucrose (C12H22O11)	Sulfur-Impregnated Carbon	Titanium Oxide (TiO_2)	Zinc Oxide (ZnO)	Zircon Sand ($ZrSiO_4$)
Nitric Acid (HNO_3)											(4)	NR	NR	(2)	(5)	(75)	NR	NR	NR
Radiolytic Hydrogen												NR	NR	NR	NR	NR	NR	NR	NR
Silica (SO_2)													NR	NR	NR	NR	NR	NR	NR
Silver mordenite															NR	NR			
Sodium Hydroxide (NaOH)															(8)	NR	NR	NR	NR
Sucrose ($C_{12}H_{22}O_{11}$)																NR	NR	NR	NR
Sulfur-Impregnated Activated Carbon																	NR	NR	NR
Titanium Oxide (TiO_2)																		NR	NR
Zinc Oxide (ZnO)																			NR

Table 3-5 Chemical Interaction Table of HLW Process Chemicals

Chemicals and Potentially Hazardous Products	Aluminum Silicate (Al_2SiO_4)	Boric Acid (H_3BO_3)	Calcium Silicate ($CaSiO_3$)	Cerium (Ce^{+4})	Ferric Oxide (Fe_2O_3)	Hydrogen Peroxide (H_2O_2)	Lithium Carbonate	Magnesium Silicate (Mg_2SiO_4)	Mercury Sulfide	Nitric Acid (HNO_3)	Radiolytic Hydrogen	Silica (SO_2)	Silver mordenite	Sodium Hydroxide (NaOH)	Sucrose (C12H22O11)	Sulfur-Impregnated Carbon	Titanium Oxide (TiO_2)	Zinc Oxide (ZnO)	Zircon Sand ($ZrSiO_4$)
Zircon Sand ($ZrSiO_4$)																			

NR – No Reaction

1 Li_2CO_3 incompatible with dilute acids (decomposes) or strong acids (may react violently)

2 Contact of NaOH with acids may cause fire or explosion

3 Ce^{4+} reacts with hydrogen peroxide to form Ce^{3+}, intended by the process

4 Hydrogen is incompatible with oxidizers

5 Sucrose is incompatible with nitric acid

6 H_2O_2 is incompatible with organics and activated carbon

7 Keep away from contact with strong oxidizing agents

8 Sodium hydroxide reacts readily with various sugars to produce carbon monoxide

9 Explosion in mercury –ammonia systems have been reported (Bretherick's Handbook of Reactive Chemicals, 6th Edition, Vol 1, pg 1704)

10 Incompatible with strong oxidizing agents, acids

Table 3-23 Post Accident Environmental Conditions[b]

Event (section)	Temp (°F, °C)	Pressure (psig)	Relative Humidity (%)	Radiation Increase	Chemical Condition (pH)	Submergence
Liquid Spill (3.4.1.1)	NC	NC	NC	Slight Increase	Caustic 7-14 pH	Potential for 13.4 inches of caustic slurry in cell
Vessel Overflow (3.4.1.2)	NC[a]	NC	NC	Slight Increase	Caustic 7-14 pH	Potential for 13.4 inches of caustic slurry in cell
Spray Leak (3.4.1.3)	NC	NC	Bounded by Molten Glass Spill	Slight Increase	Caustic 8-13 pH	Bounded by Spill/Overflow
Molten Glass Spill (3.4.1.4)	660 °F (350 °C)	Increase 1.0 psig	20 %	Slight Increase	NC	Potential for 1.2 inches of molten glass on tunnel floor
Canister Drop (3.4.1.5)	NC	NC	NC	Slight Increase[c]	NC	NC
Fire in Sulfur-Impregnated Activated Carbon Bed	NC	NC	NC	NC	Toxic Release	NC
Secondary Waste Container Drop (3.4.1.6)	NC	NC	NC	Slight Increase	NC	NC
H2 Explosions (3.4.1.7)	NC	NC	NC	NC	NC	NC
Melter Offgas (3.4.1.8)	750 °F (400 °C)	Slight Increase	Steam release 3.2 Kg/min for 15 min	Slight Increase	Toxic Release	NC
Ammonia Release (3.4.1.12)	NC	NC	NC	NC	Toxic Release	NC

a NC = no change expected in the environmental conditions.

b Environmental conditions estimated from calculations referenced in the section 3.4.1 DBE Analysis, MN-24590-01-00001, *WTP Radiological Control Manual*, and 24590-WTP-RPT-ESH-01-00, *Determination of Extremely Hazardous Substances.*

c Glass release due to container drops in non R5/R3 areas is not credible.

- The HEPA material shall meet the performance requirement of ASME N-509, Chapter 4.1, and be capable of withstanding 70 % relative humidity.
- The HEPA filters shall be inspected in accordance with ASME AG-1, Article FC-5000. The inspection program will ensure HEPA filtration of airborne releases.

C5 Exhaust Fans

- The C5 exhaust fans will be rated based on tests in accordance with ANSI/AMCA 210, and will comply with the AMCA Certified Rating Program. The equipment specified will ensure that the exhaust fans will be capable of withstanding potential moisture challenges due to process upsets.
- The C5 exhaust fan will ensure adequate flow in the C5 exhaust system to maintain C5 areas pressure negative relative to adjacent areas (cascade).
- The control and instrumentation requirements for exhaust fan safety controls will be specified in accordance with ISA S84.01, IEEE 338, IEEE 344, IEEE 379, IEEE 384, and IEEE 1023.
- The exhaust fans will be fabricated from corrosion resistant materials.

Secondary Offgas Treatment Fire Detection and Deluge

Standards - TBD

4.3.5.5 System Evaluation

The C5 ventilation system provides continuous depression in the C5 areas and filtration of the exhaust. It maintains depression and filtration during and after the seismic DBE, and on loss of site power. Continuous operation during equipment failure is provided by redundant fans and filter trains. Exhaust is treated by providing two stages of high efficiency filters. The equipment and supports are designed to operate after the seismic DBE. Continuous operation during loss of site power is provided by the plant emergency power system. The C5 ventilation system design follows the ASME national standard for nuclear air and gas treatment. Implementation of these designs will be reflected on issued design documents. The state regulatory agency requires demonstration that the design complies with the code.

ISA S84.01 is applied for all automatically executed safety instrumented systems, to provide the guidance to ensure the required reliability of those systems ($\sim 5.0 \times 10^{-3}$/yr). A tailored version of IEEE 338 supplements ISA S84.01 in designing safety instrumented systems so they can be tested to prove that they adequately perform their required safety functions. A tailored version of IEEE 344 is applied to those safety instrumented systems required to function during and (or) after a seismic event. A tailored version of IEEE 379 is applied to safety instrumented systems to supplement ISA S84.01 in design considerations ensuring that the single failure criterion of those systems is met. A tailored version of IEEE 384 is applied to safety instrumented systems to supplement ISA S84.01 in design considerations for independence of multiple-channel safety systems. Finally, a tailored version of IEEE 1023 is applied to all safety functions requiring indication and/or alarm at a safety qualified operator interface.

4.3.5.6 Controls (TSRs)

The C5 exhaust system ductwork to the exhaust fans, including the HEPA filter housings, are passive design features, and do not require maintenance or surveillance to demonstrate operability. The WTP

- The exhaust fans will be fabricated from corrosion resistant materials.

4.4.2.5 System Evaluation

The C3 cascade ventilation system provides continuous depression in the C3 exhausted areas and filtration of the exhaust during normal operations. Operation is provided by a AMCA rated exhaust fan and ASME filter train and ductwork. Treatment of the exhaust is provided by providing high efficiency filters. The C3 ventilation system design follows the ASME national standard for nuclear air and gas treatment. Implementation of these designs will be reflected on issued design documents. Demonstration that the design complies with the code is required by the state regulatory agency.

ISA S84.01 is applied for all automatically executed safety instrumented systems to provide the necessary guidance to ensure the required reliability of those systems. A tailored version of IEEE 338 is applied to supplement ISA S84.01 in designing safety instrumented systems so they can be tested to prove that they adequately perform their required safety functions. Finally, a tailored version of IEEE 1023 is applied to all safety functions requiring indication and/or alarm at a safety qualified operator interface.

4.4.2.6 Controls (TSRs)

The C3 exhaust system ductwork, including the HEPA filter housings from the ventilated areas up to the exhaust fans, will provide confinement of aerosols. This requirement is considered a passive design feature (sections 5.5.13 and 5.6.4).

The C3 exhaust system HEPA filter banks will provide a minimum filter efficiency of 99.9 % for 0.3 micron particulates. The HEPA filters are design features. The surveillance requirements to test and verify HEPA filter bank performance (decontamination factor) are discussed in section 5.5.3.

The C3 exhaust system exhaust fans will, in conjunction with the exhaust ductwork, maintain a negative pressure in the C3 areas with respect to the C2 areas and direct exhaust air through the HEPA filters. The safety controls (instrument and control) and monitoring systems necessary to ensure airflow are discussed in section 5.5.3.

4.4.3 Offgas Treatment System

The vessel vent header collects air emissions from the vessels and connects to the melter offgas system downstream of the wet electrostatic precipitator (WESP). Based on the results of the DBE analysis the offgas treatment system is designated SDS. This includes the SDS confinement boundary provided by the film cooler, SBS, WESP, high efficiency mist eliminator (HEME), HEPA filter housings, and fan housing <u>and the vessel containing sulfur-impregnated activated carbon</u>. The HEPA preheaters, HEPA filters, SBS level control systems, and exhaust fans are also designated SDS.

The SDS items discussed in this section are as follows:

- Vessel vent system ductwork from the vessels up to the melter offgas ductwork
- Melter offgas ductwork including the SBS, WESP, HEME, pressure boundary, HEPA filter housings up to the exhaust stack
- HEPA filters and preheaters

- Exhaust fans
- ~~Mercury~~ Activated Carbon column

4.4.3.1 Credited Safety Function

The safety function of the offgas treatment system is to provide primary confinement of aerosols to prevent releases that may result in consequences to the public, co-located worker and facility worker above radiation exposure standards in the SRD.

4.4.3.2 System Description

The vessel ventilation subsystem consists of individual pipes from each vessel connected to a common header. The header is sloped, to drain to the offgas drains collection vessel, to prevent blocking. From the header the vessel vent system connects to the melter offgas system downstream of the wet electrostatic precipitator. Melter offgas is drawn through the film cooler to the SBS. The SBS offgas is routed to the WESP.

The combined offgas stream after the WESP is drawn through the HEME and heated by an electric preheater. The offgas is then drawn through the HEPA filters, and processed through the secondary offgas treatment system to remove hazardous gases (~~volatile organic compounds,~~ Hg, I, CL, and F, volatile organic compounds and NO_x~~, I, CL, and F~~) ~~in~~. ~~t~~The sequence of treatment operations are ~~mercury~~ activated carbon column for mercury, silver mordenite column for I, Cl, and F, thermal catalytic oxidizer for volatile organic~~, NO_x~~ and the selective catalytic reducer for NO_x, ~~and silver mordenite column~~ before being released to the stack.

4.4.3.3 Functional Requirements

The offgas treatment system will be capable of filtering exhaust prior to discharge to the environment. The offgas exhaust fans, in conjunction with the ductwork and HEPA filter housings, will direct the exhaust air to the environment through the HEPA filters. The fans have provisions for automatic switchover to the standby fan, on detection of low-low flow, from the operating fan. The offgas treatment system HEPA filter banks will provide an efficiency of 99.9 % for particles of 0.3 microns. The HEPA filter preheaters protect the filters from becoming saturated with moisture, thereby extending the operational life of the filters and preventing blinding of the filters.

The systems, structures and components that comprise ITS barriers for the activated carbon column must meet the following functional requirements.

Carbon monoxide monitoring
The detector(s) and analysis devices must be sufficiently sensitive to register an increase in carbon monoxide across the bed under the full range of melter operations and offgas flows. The monitor(s) must be sufficiently sensitive that the isolation/quench strategy can be implemented well before the mercury release exceeds 526 g in any 10 minute period.

Isolation valves
The valves must seal sufficiently tight to limit the amount of offgas that enters the bed to a level that will starve the fire of oxygen and cause it to self-extinguish.

Rating Program. The exhaust fans will ensure adequate flow in the system to maintain the required negative depression in the melter plenum.

- The control and instrumentation requirements for exhaust fan safety controls will be specified in accordance with ISA S84.01, IEEE 338, and IEEE 1023.
- The exhaust fans will be fabricated of corrosion resistant materials.

Activated Carbon Column

- The flow rate of water for carbon bed fire protection shall be ASME AG-1, paragraph FE 4623.3.
- Piping of the water used in flooding the carbon bed shall be designed and fabricated according to ASME 31.3, Process Piping.

4.4.3.5 System Evaluation

The offgas system piping and integral components will provide a filtered exhaust path for melter offgas during normal and abnormal operating conditions.

The offgas system piping and associated components are designed to standards that will ensure that they will withstand NPH events, including a SC-III seismic event, without losing confinement. The film cooler and its associated line to the submerged bed scrubber have a potential to become restricted, the design includes a fully line on standby, actuated automatically by melter pressure. This provides an alternate path for melter offgas in the event the primary line to the SBS has reduced capacity. Offgas system components downstream of the offgas exhausters are designed to remain functional and leak free to direct melter offgas to HEPA filters and ultimately the exhaust stack. Continuous operation during equipment failure is provided by redundant fans and filter trains. Treatment of the exhaust is provided by providing two stages of high efficiency filters. The offgas HEPAs and preheater have a sealed housing to ensure adequate filtration. A melter relief device on the melter offgas system is provided to vent each melter at a predetermined point and route the discharge to the melter cell. This feature is needed to protect against inadvertent glass pours due to a melter pressurization. The materials and methods of construction of the melter offgas system and its components are appropriate to ensure an adequate pressure boundary and filtration for the exhaust path.

The offgas exhaust fans, in conjunction with the ductwork and HEPA filter housings, will reliably direct the exhaust air to the environment through the HEPA filters. The design of the SDS fans uses ISA S84.01 for all automatically executed safety instrumented systems to provide the necessary guidance to ensure the required reliability of those systems ($\sim 5.0 \times 10^{-3}$/yr). A tailored version of IEEE 338 is applied to supplement ISA S84.01 in designing safety instrumented systems so they can be tested to prove that the adequately perform their required safety functions. A tailored version of IEEE 1023 is applied to all safety functions requiring indication and/or alarm at a safety qualified operator interface.

Volatile compounds and toxic gases are removed in the secondary offgas treatment system. Sulfur-impregnated activated carbon bed sorbs elemental mercury at sulfur active sites through chemisorption. All other speciated mercury as well as other compounds are sorbed by the bed through physiosorption. The mercury column includes carbon monoxide monitors on the inlet and outlet of the column to detect localized combustion within the activated carbon beds. Fire developing within the activated carbon beds is extinguished by a water deluge system.

4.4.3.6 Controls (TSRs)

The offgas treatment system, including the HEPA filter housings from the vessels up to the exhaust fans, will provide a flow path. The offgas ductwork, including the HEPA filter housings from the ventilated areas up to the exhaust fans, will provide confinement of aerosols. These requirements are considered a passive design features. The WTP configuration management program, addressed as administrative controls in the TSRs, will ensure that the design feature will continue to fulfill its safety function (sections 5.5.13 and 5.6.4).

The offgas treatment system HEPA filter banks will provide a minimum filter efficiency of 99.9 % for 0.3 micron particulates. The surveillance requirements to test and verify HEPA filter bank performance (decontamination factor) are discussed in section 5.5.5.

The offgas exhaust fans will, in conjunction with the ductwork, maintain a negative depression in the melter plenum. The safety controls (instrument and control), and monitoring systems necessary to ensure airflow are discussed in section 5.5.5. Monitoring for carbon monoxide is necessary in the mercury column to detect a fire. The deluge system is necessary to extinguish it.

4.4.4 Process Interlocks

The SDS process interlocks involve (1) an interlock with the canister high-high level indicator and the melter pour cycle to prevent a glass spill from overfilling a canister; (2) high-high liquid level in the SBS vessel, the SBS condensate receiver vessel, and the acidic waste vessels to prevent overflows; and (3) a melter feed interlock to shut down the melter feed on high melter pressure.

4.4.4.1 Credited Safety Function

High-High Canister Level Interlock

The safety function of the high-high canister level interlock is to ensure containment of radiological materials.

Melter Feed Interlock on High Pressure

The safety function of the melter feed shut off interlock is to limit the material at risk during an offgas event.

High-High Vessel Level Interlock

SBS high-high liquid level and acidic waste vessel high-high liquid interlocks prevent overflows of the vessels. The SBS and SBS condensate receiver vessel high-high level also prevents a liquid level that could potentially block the offgas system.

4.4.4.2 System Description

The interlocks are designed to control or mitigate accident conditions resulting in glass spills, overflows, or failure of the offgas system.

Table 4-1 Important to Safety: Description and Basis for Safety Design Class Structures, Systems, and Components

SDC System (Major Components)	Safety Function	Functional Requirements/ Standards (Chapter 4)	Basis for ITS Designation (Chapter 3)
Emergency Electrical Power	Provide reliable power for SDC components	Section 4.3.12	Sections 3.4.1.1, 3.4.1.2, 3.4.1.3, 3.4.1.4, 3.4.1.5, 3.4.1.6, 3.4.1.7, 3.4.1.8, 3.4.1.9 and 3.4.2.1
IHLW Canister Cask and Secondary Waste Drum Cask	Provide containment and prevent pressurization	Section 4.3.13	Sections 3.4.1.5, 3.4.1.6, 3.4.1.9, and 3.4.2.1
Impact Absorbers in Cask Handling Tunnel	Provides mitigation for dropped canister in C3 area including during a seismic event	Section 4.3.14	Sections 3.4.1.5 and 3.4.2.1
Ammonia Tanks/Piping	Provides confinement of anhydrous ammonia	Section 4.3.15	Sections 3.4.1.12 and 3.4.2.1
Secondary offgas treatment carbon bed CO monitoring isolation valves and deluge system	Prevent or mitigate combustion in activated carbon	Section 4.4.3	Section 3.4.1.5

Table 4-2 Important to Safety: Description and Basis for Safety Design Significant Structures, Systems, and Components

SDS System (Major components)	Safety Function	Functional Requirements/ Standards (Chapter 4)	Basis for ITS Designation (Chapter 3)
Shield hatches, shield doors, confinement doors that provide an engineered air gap and shielding	Ensure confinement of radioactive materials during normal conditions Shield door will withstand impacts (not allow shine paths after impacts with loaded cranes and bogies)	Section 4.4.1	Sections 3.4.1.11 and 3.4.2.1
C3 Area Ventilation Exhaust System Ductwork	Ensure confinement of radioactive materials during normal operations	Section 4.4.2	Normal operations
C3 Area Ventilation Exhaust System HEPA Filters	Ensure filtration of radioactive materials during normal operations	Section 4.4.2	Normal operations
C3 Area Ventilation Exhaust System Fans	Provide secondary confinement of aerosolized materials during normal operations	Section 4.4.2	Normal operations
Offgas Treatment System Ductwork	Ensure confinement of radioactive materials during normal operations	Section 4.4.3	Normal operations
Offgas Treatment System HEPA Filters	Ensure filtration of radioactive materials during normal operations	Section 4.4.3	Normal operations
Offgas Treatment System Fans and Safety Controls to Transfer to Standby Fan	Provide secondary confinement of aerosolized materials during normal operations	Section 4.4.3	Section 3.4.1.8
~~Secondary offgas treatment carbon bed CO_2 monitoring isolation valves and deluge system~~	~~prevent or mitigate combustion in activated carbon~~	~~Section 4.4.3~~	~~Section 3.4.1.5~~
Canister High-High Level Interlock with Melter Airlift	Prevent overfilling of the canister	Section 4.4.4	Section 3.4.1.4
Interlock to Stop Melter Feed on High Melter Pressure or Activation of the Standby Line	Mitigates the material at risk and source term in the event that the melter is pressurized	Section 4.4.4	Section 3.4.1.8

Attachment 2

Authorization Basis Amendment Request 24590-WTP-SE-ENS-03-518, Revision 0, plus attachments

Safety Evaluation For Design

Safety Evaluation No.: 24590-WTP-SE-ENS-03-518	**Rev. #** 0
Design Document Evaluated: This ABAR addresses the Elimination of the 125 VDC Batteries as discussed in DTD 24590-HLW-DTD-PL-03-001. Specifically, this ABAR addresses the changes implemented in the documents listed below: 24590-HLW-P1-P01T-00002, Rev. 2 24590-HLW-P1-P01T-00011, Rev. 7	**Rev. #** ~~N/A~~ JK 9/12/03
Consists of Parts: ☒ 1 ☒ 2 ☒ 3 ☒ 4	
Title: Removal of the HLW ITS 125 VDC Batteries	

Description of design change:

The three ITS 125 VDC batteries (UPE-BATT-3000XA, UPE-BATT-3000XB, UPE-BATT-3000XC) in the annex at the 0 ft elevation have been removed from the design. These batteries provided 125 VDC power to the control circuits of the HLW ITS 4.16-0.48 kV Load Center 4160 V main circuit breakers. The main circuit breakers located on the HLW ITS Load Centers have been replaced with load interrupter switches.

Reason for design change:

The primary protection for the HLW ITS Load Centers is provided by the BOF facility 4160 V feeder circuit breakers. As protection of these Load Centers is already provided by the 4160V feeder circuit breaker at the BOF switchgear, there is no need for the additional primary circuit breakers at the HLW transformers for protection. The change from circuit breakers to load interrupter switches allows for the removal of the 125 VDC ITS batteries, and associated chargers.

Complete the following parts as appropriate:

Part 1 Safety Screening

Complete Part 1 for all design changes requiring this form. Refer to Appendix 2 of 24590-WTP-GPP-SREG-002 for guidance. If all Part 1 answers are 'No', or for a 'Yes' answer the design is safe and consistent with the AB, the design change does not require further safety review or an AB change. If this is the case, sign this form after Part 1 and submit to PDC. After each question briefly describe the basis for each answer..

		YES	NO
1.	Does the change modify or delete a standard prescribed in the *Safety Requirements Document Volume II* (SRD)?	☒	☐
	Basis: Replacing the circuit breakers and the associated ITS 125 VDC batteries in the HLW facility with load interrupters does not modify or delete a standard prescribed in the SRD.		
2.	Does the change alter the location, function, or reliability of an SSC as described in the AB? *This question refers to SSCs described in the LCAR and PSAR, including text descriptions and tables in chapter 2 of the PSAR.*	☒	☐
	Basis: Removing the batteries that provided power to the circuit breakers for the HLW Load Centers and replacing the circuit breakers with load interrupter switches simplifies the system and results in negligible reliability impacts. The circuit breakers on the HLW Load Centers are not required since the primary protection for the HLW ITS Load Centers is provided by the BOF facility 4160 V feeder circuit breakers. The HLW Load Centers have always been protected by the BOF 4160V feeder circuit breakers. Removing the batteries and circuit breakers, and adding load interrupters, does not affect the function of the HLW Load Centers.		
3.	Is there a change in classification, new items being classified, or existing items deleted as described in the PSAR?	☒	☐

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	Basis: The three ITS 125 VDC batteries were removed from the design since the 4160 V main breakers in the HLW Load Centers were not required and were replaced with load interrupters. Since the primary protection for the HLW ITS Load Centers is already provided by the BOF facility 4160 V feeder circuit breakers, it was determined that the 4160 V main circuit breakers in the HLW Load Centers are no longer required. The load interrupter switches are manual shut offs and do not require the ITS 125 VDC batteries to open or close the circuit.		
4.	Does the change affect the safety function descriptions in chapter 4 of the PSAR?	☒	☐
	Basis: Section 4.3.12 includes the ITS 125 VDC battery/battery charger systems. The general description of the ITS 125 VDC batteries will be removed from this section. Section 4.3.12.2 is the system description of the Emergency Electrical Power system. This section includes a description of the three ITS 125 VDC batteries, which will be removed from this section. Section 4.3.12.4 is the standards for the Emergency Electrical Power system. This section includes the standards that apply to the ITS 125 VDC battery/battery charger systems, which will be removed. Section 4.3.12.6 is the technical safety requirements (TSRs) for the Emergency Electrical Power system. The TSRs for the DC power supplies have been removed since the ITS 125 VDC batteries have been removed.		
5.	Does the change create a new hazard or affect the hazard or accident analysis contained in the PSAR?	☐	☒
	Basis: Replacing the main circuit breakers with load interrupter switches or removing the ITS 125 VDC batteries does not create any new hazards. These changes do not affect the hazard or accident analysis contained in the PSAR.		
6.	Does the change affect criticality safety?	☐	☒
	Basis: Replacing the main circuit breakers with load interrupter switches or removing the ITS 125 VDC batteries does not affect any credited parameters in the WTP Criticality Safety Evaluation Report (24590-WTP-RPT-NS-01-001, Rev 2).		
7.	Does the change have the ability to affect exposures to radiation (doses), contamination levels, or releases of radioactivity to the environment? If so, has an ADR been completed?	☐	☒
	Basis: The removal of the ITS 125 VDC batteries is a result of changing from 4160 V main circuit breakers in the HLW facility to load interrupter switches. This change does not affect the exposures to radiation, contamination levels, or releases of radioactivity to the environment. These changes do not affect the functionality of the Load Centers or any SSC downstream of the Load Centers.		
8.	Are any other Authorization Basis documents affected by this change?	☐	☒

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	Basis: The removal of the three ITS 125 VDC batteries is a result of changing from 4160 V main circuit breakers to load interrupters for the HLW Load Centers. This change does not affect any other AB documents.		
9.	As a result of this design change, is an ISM meeting required?	☐	☒
	Basis: Removing the three ITS 125 VDC batteries is a result of changing from 4160 V main circuit breakers to load interrupters for the HLW Load Centers. This change in the design does not require an ISM meeting. The electrical hazards associated with these changes are not typically addressed in the ISM process.		

Further safety review required? ☒ Yes ☐ No

AB change required? ☒ Yes ☐ No

If either answer above is 'Yes', continue with this form. If both answers are 'No', sign here and send Part 1 of this form to PDC.

Safety Evaluation Preparer:	Michael Toyooka *Print/Type Name*	[signature] *Signature*	8/27/03 *Date*
Design Document Originator/ Supervisor:	David Gott *Print/Type Name*	David Gott *Signature*	8/28/03 *Date*

Only required for screenings requiring NO ABCN or ABAR:

H&SA Lead:	N/A *Print/Type Name*	*Signature*	*Date*

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Part 2 Safety Evaluation (Complete Part 2 for all AB changes)

Complete Part 2 to determine the approval authority for the AB change. Obtain concurrence from H&SA Lead.

REGULATORY		**YES**	**NO**
1.	Based on the answers to the above technical questions and any other analysis, does the change create a new DBE?	☐	☒
	Basis: Replacing the circuit breakers with load interrupter switches and removing the three ITS 125 VDC batteries from the design does not create a new DBE. The ITS 125 VDC batteries were removed as a result of the main circuit breakers being replaced with load interrupter switches.		
2.	Based on the answers to the above technical questions and any other analysis, does the change result in more than a minimal (≥10 %) increase in the frequency or consequence of an analyzed DBE as described in the Safety Analysis Report?	☐	☒
	Basis: The change from main circuit breakers for the HLW Load Centers to load interrupter switches does not result in more than a minimal increase in the frequency or consequence of an analyzed DBE as described in the PSAR. As a result of this change the three ITS 125 VDC batteries are no longer required. The removal of these batteries do not result in more than a minimal increase in the frequency or consequence of an analyzed DBE as described in the PSAR. The 4160 V main circuit breakers for the HLW ITS Load Centers and the three ITS 125 VDC batteries are not credited in any of the HLW DBEs.		
3.	Based on the answers to the above technical questions and any other analysis, does the change result in more than a minimal decrease in the safety functions of important-to-safety SSCs or change how a Safety Design Class SSC meets its respective safety function?	☒	☐
	Basis: The removal of three ITS 125 VDC batteries does not result in more than a minimal decrease in the safety function of ITS SSCs. The safety function of the SDC Load Centers is to maintain the required power to ITS loads. The removal of the three SDC 125 VDC batteries results from changing the main circuit breakers for the HLW Load Centers to load interrupter switches. The change from circuit breakers to load interrupter switches does affect how the SDC Load Centers meet their respective safety function. However, these were unnecessary redundant circuit breakers and were replaced with load interrupter switches. This will not significantly impact the safety function of the SDC Load Centers.		
4.	Does the change result in a noncompliance with applicable laws and regulations (i.e., 10 CFR 820, 830, and 835) or nonconformance to top-level safety standards (i.e., DOE/RL-96-0006)?	☐	☒
	Basis: The *Procedural Rules for DOE Nuclear Activities*, 10 CFR 820, addresses compliance, violation, or enforcement issue; exemption from safety requirements or reporting of supplier defective products; or inaccurate or incomplete information. The removal of the three ITS 125 VDC batteries is not related to what is addressed in 10 CFR 820. *Nuclear Safety Management*, 10 CFR 830, addresses requirements related to technical safety requirements (TSRs), unreviewed safety questions (USQs) and their processes, documented		

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	safety analyses (DSAs), hazard controls, major modifications, facility safety classified SSCs, and the quality assurance program (QAP). The removal of the three ITS 125 VDC batteries does not result in a noncompliance with the requirements addressed in 10 CFR 830. The removal of the three ITS 125 VDC batteries that is addressed in this safety evaluation does not result in a noncompliance with the requirements in 10 CFR 835. *Occupational Radiation Protection*, 10 CFR 835, addresses radiation protection standards, limits, and program requirements for protecting individuals from radiation resulting from the conduct of DOE activities. The removal of the three ITS 125 VDC batteries that is addressed in this safety evaluation is in conformance with the top-level safety standards of DOE/RL-96-0006 in that the system still provides adequate defense in depth.		
5.	Does the change fail to provide adequate safety?	☐	☒
	Basis: The removal of the three ITS 125 VDC batteries, is the result of replacing the 4160 main circuit breakers with load interrupter switches. These changes still provide adequate safety. The change to the design addressed in this safety evaluation does not create any new hazards, DBEs, or affect the hazard or accident analysis. The change to the design addressed in this safety evaluation results in only a negligible impact to the reliability and does not affect the consequence of an analyzed DBE. The change from circuit breakers for the HLW Load Centers to load interrupter switches, allows for the removal of the ITS 125 VDC batteries. The function of the ITS 125 VDC batteries was to provide power to the circuit breakers. The circuit breakers in the BOF facility have not been removed, which allows for the redundant circuit breakers in the HLW facility to be replaced with load interrupter switches. This change would only have a negligible affect on the safety function of the SDC Load Centers. Replacing the 4160 main circuit breakers for the HLW ITS Load Centers with load interrupter switches does not have a significant impact to the ORA (CCN: 064459). As a result of replacing the circuit breakers with load interrupter switches the three ITS 125 VDC batteries have been removed. This change also does not have a significant impacts to the ORA.		
6.	Does the change result in nonconformance to the contract requirements associated with the authorization basis document(s) affected by the change? See Contract Standard 7(e)(2).	☐	☒
	Basis: The changes to the AB documents addressed in this safety evaluation include removal of sections containing descriptions of the ITS 125 VDC batteries. The removal of the ITS 125 VDC batteries is a result of replacing the 4160 main circuit breakers in the HLW facility with load interrupter switches. The use of circuit breakers or load interrupter switches are not described in the AB. The changes to the AB do not result in nonconformance of the contract requirements associated with the AB documents affected by the change.		

Safety Evaluation For Design

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Design Document Evaluated:	This ABAR addresses the Elimination of the 125 VDC Batteries as discussed in DTD 24590-HLW-DTD-PL-03-001. Specifically, this ABAR addresses the changes implemented in the documents listed below: 24590-HLW-P1-P01T-00002, Rev. 2 24590-HLW-P1-P01T-00011, Rev. 7	**Rev. #** ~~N/A~~ 2 JK 9/2/03

7.	Does the change result in an inconsistency with other commitments and descriptions contained in portions of the authorization basis or an authorization agreement not being revised?	☐	☒
	Basis: Replacement of the circuit breakers and associated ITS 125 VDC batteries with load interrupter switches does not result in an inconsistency with other commitments and descriptions contained in portions of the AB or an authorization agreement not being revised. This change does not affect the requirements of the system or commitments in the WTP responses.		

If all Part 2 questions are answered 'No', a BNI-approved AB change (ABCN) is permitted. Complete Part 3 of this form and send it to the E&NS AB Coordinator. If any Part 2 question is answered 'Yes', a DOE-approved AB change (ABAR) is required. Complete Parts 3 ***AND*** *4 of this form and send to the E&NS AB coordinator.*

BNI-approved AB change? ☐ Yes ☒ No

DOE-approved AB change? ☒ Yes ☐ No

Concurrence:	**Initial**	**Date**
H&SA Lead:	[signature]	9/28/03

P.L 8/28/03

Safety Evaluation No.: 24590-WTP-SE-ENS-03-518		**Rev. # 0**
Design Document Evaluated:	This ABAR addresses the Elimination of the 125 VDC Batteries as discussed in DTD 24590-HLW-DTD-PL-03-001. Specifically, this ABAR addresses the changes implemented in the documents listed below: 24590-HLW-P1-P01T-00002, Rev. 2 24590-HLW-P1-P01T-00011, Rev. 7	**Rev. #** ~~N/A~~ 0 MK 9/2/03

Part 3 BNI-Approved AB Change

List affected AB documents, obtain necessary concurrences and approval, and send this form to the E&NS AB coordinator. If an SRD change is involved, obtain PMT and PSC reviews.

Affected Authorization Basis Documents:

Title	**Document Number**	**Rev**	**Section**
Preliminary Safety Analysis Report to Support Construction Authorization; HLW Facility Specific Information	24590-WTP-PSAR-ESH-01-002-04	0c	4.3.12, 4.3.12.2, 4.3.12.4, 4.3.12.6, 5.5.1, 5.5.5.11 and 5.5.12

Concurrences: (check affected departments)

Review Required?	**Organization**	**Print / Type Name**	**Signature**	**Date**
☒	Safety Evaluation Preparer	Michael Toyooka	[signature]	8/27/03
☒	AB Document Custodian	Don Foss	[signature]	8/28/03
☐	Quality Assurance			
☒	Engineering	Dilip Patel	DJ [signature]	8/28/03
☒	Affected Area Project Manager	Phil Schuetz	[signature]	8/28/03
☒	Operations	Cindy Beaumier	[signature]	8/28/03
☐	Construction			

Other Affected Organizations	**Print / Type Name**	**Signature**	**Date**
Electrical	Bill Cheung	for BB [signature]	8/28/03

BNI-Approved AB Change Approved:

E&NS Manager: Fred Beranek (*Print/Type Name*) — [signature] (*Signature*) — 9/2/03 (*Date*)

Safety Evaluation No.: 24590-WTP-SE-ENS-03-518		**Rev. #** 0
Design Document Evaluated:	This ABAR addresses the Elimination of the 125 VDC Batteries as discussed in DTD 24590-HLW-DTD-PL-03-001. Specifically, this ABAR addresses the changes implemented in the documents listed below: 24590-HLW-P1-P01T-00002, Rev. 2 24590-HLW-P1-P01T-00011, Rev. 7	**Rev. #** ~~N/A~~ 2 JK 9/2/03

Part 4 DOE-Approved AB change

Decision to deviate: ☒ Yes ☐ No

If 'Yes', DTD No.: 24590-HLW-DTD-PL-03-001 Rev: 0

List the AB change implementing activities and the projected completion dates:

Activity	**Date**
Inform DOE that AB has been revised and formally transmit electronic version	30 days or less after DOE approval
Distribute revised controlled copy pages / update WTP Electronic Library	30 days after DOE approval

Revise the following implementing documents:

Documents	**Describe extent of revisions**	**Date**
1 NONE		

Describe other activities	**Date**
1 NONE	

Concurrence/confirmation of AB change if SRD is changed:

PMT Chair: N/A
Print/Type Name *Signature* *Date*

PSC Chair: N/A
Print/Type Name *Signature* *Date*

Certification of Continued SRD Adequacy:

If this ABAR involves the deletion or modification of a safety criterion, code, or standard previously identified or established in the SRD, Project Director certification is required. The Project Director's signature certifies that the revised SRD continues to identify a set of standards that provides adequate safety, complies with WTP applicable laws and regulations, and conforms with top-level safety standards and principles. This certification is based on adherence to the DOE/RL-96-0004 standards identification process and successful completion of review and confirmation by the PSC.

WTP Project Director: N/A
Print/Type Name *Signature* *Date*

Attachments: (page changes for all ABARs)

Attachment 1 – Proposed Changes to Preliminary Safety Analysis Report to Support Construction Authorization; HLW Facility Specific Information (24590-WTP-PSAR-ESH-01-002-04), Sections 4 and 5.

24590-WTP-SE-ENS-03-518, Rev 0

Attachment 1

Proposed Changes to the Preliminary Safety Analysis Report to Support Construction Authorization; HLW Facility Specific Information (24590-WTP-PSAR-ESH-01-002-04)

Document Part	Title	Affected Pages
Section 4	Important to Safety Structures, Systems, and Components	4-27 and 4-28
Section 5	Derivation of Technical Safety Requirements	5-6, 5-11, 5-17, 5-18, and 5-19

# of pages (including cover sheet):8

4.3.12 Emergency Electrical Power

For normal SDC operation, the 4.16 kV SDC power is provided by BOF from three independent 4.16 kV EDG switchgears supplied by three independent 13.8/4.16 kV step down transformers from the BOF main 13.8 kV switchgears. Upon loss of off-site power, three independent 4.16 kV emergency diesel generators (EDG) provide SDC power to the three independent 4.16 kV EDG switchgears. The SDC power from BOF is routed in SDC ductbanks to HLW SDC load centers. The SDC load centers and SDC motor control centers power SDC loads in the HLW facility.

Two ITS UPSs (A and B) with 480 – 208Y/120 VAC output, step down transformers, and distribution panels provide power to loads that can not withstand any loss of power. Non-ITS HVAC systems provide cooling to switchgear, load centers, UPS and battery, ~~125 VDC battery/battery charger systems,~~ and motor control centers under normal and emergency HVAC conditions. Under normal HVAC conditions, the HVAC cooling is provided by two 50 % central air handling units with common ductwork. Upon failure of normal HVAC equipment, the emergency HVAC units become operable by thermostat settings. The emergency HVAC units are seismically supported and ITS powered.

4.3.12.1 Credited Safety Function

The safety function of the emergency power system is to maintain the required power, upon loss of normal power, to ITS loads.

4.3.12.2 System Description

Emergency Electrical Power System

The emergency power (SDC) for HLW is provided from BOF via three independent 4.16 kV feeds in ductbank. The 4.16 kV emergency power is backed by three independent EDGs if normal power to the three emergency 4.16 kV buses is lost. The BOF 4.16 kV feeds terminate at HLW ITS Load Centers in the HLW Annex floor (elevation 0 ft). These load centers transform 4.16 kV to 480 V and distribute SDC power to motor control centers and larger loads. The three load centers and motor control centers are in separate fire rated rooms. The three emergency power channels are A, B, and C.

Uninterruptible Power

There are two ITS UPS systems (A and B), each with 480 VAC output. Each UPS system consists of battery set (sealed batteries), charger, inverter, static auto transfer switch, manual bypass switch, regulating transformer, and 480 – 208Y/120 step down transformers and 208Y/120 VAC distribution panels. The UPS battery rooms are maintained at 77 °F nominal by non-ITS HVAC system in accordance with ASHRAE 1999 supported by IEEE 484.

~~DC Power~~

~~ITS DC power is available from three 125 VDC batteries assigned as ITS-A, ITS-B, ITS-C that are maintained on a continuous float charge by a dedicated charger/rectifier. The batteries are sealed; the charger is rated to carry all loads while charging the battery. The battery rooms are maintained at 77° F by non-ITS HVAC system per ASHRAE 1999 supported by IEEE 484. The charger/rectifier is powered by ITS power backed by emergency diesel generators. Typical loads are 13.8 kV switchgear control and load center control at 125 VDC.~~

4.3.12.3 Functional Requirements

The emergency electrical power system will maintain electric power to SDC loads identified in the ISM process.

4.3.12.4 Standards

The emergency electric power system will be designed and constructed in accordance with the following.

- The power systems and circuits will be designed in accordance with IEEE 308, IEEE 344, and IEEE 384. The raceways for the circuits will be designed to IEEE 628 and IEEE 741.
- The UPS is designed to meet the required safety function. The power system will be designed in accordance with IEEE 344, IEEE 379, IEEE 484, IEEE 485, and IEEE 946.
- ~~The DC power is designed to meet the required safety function. The DC power supply will be designed and installed in accordance with and IEEE 344, IEEE 379, IEEE 484, and IEEE 485. The DC power units will be maintained and tested in accordance with IEEE 450.~~

4.3.12.5 System Evaluation

The emergency power system provides sufficient onsite power to ensure SDC functions are maintained on loss of offsite power. Emergency power is provided to the HLW load centers by three independent ITS unit substations, which are backed by three emergency diesel generators. Power distribution is through separated channels and seismically qualified. The independence, redundancy, and seismic qualification of the system and components have been determined through the reliability requirements determined by the ISM process. The design criteria for the project have been determined by tailoring of the standards for nuclear power generating stations. These tailored standards will be implemented in a reliable and consistent manner throughout the design and construction of the WTP.

4.3.12.6 Controls (TSRs)

Surveillance and maintenance requirements for the emergency electric power system include periodic verifications of system operability. Surveillance and maintenance requirements for the UPS include periodic verifications of UPS system operability~~. Surveillance and maintenance requirements for the DC power supply include periodic verifications of operability~~ (section 5.5.12).

4.3.13 Export Casks

Two types of export casks are required for the HLW facility: one for the export of the IHLW canister and the other for the export of secondary solid radioactive wastes.

4.3.13.1 Credited Safety Function

The purpose of the cask is to provide radiation shielding and confinement of the IHLW canister or waste drum on export from the facility in the export or truck bay, including during drop events. The casks will survive immersion in a fire with a maximum temperature of 1475 °F for 30 minutes.

Emergency Conditions – The minimum staff during emergency conditions is necessary to respond to the spectrum of accidents analyzed in Chapter 3. The minimum staff will make prompt initial notifications and implement initial protective actions to preclude or reduce the exposure of individuals affected by hazards or unsafe conditions during an emergency.

Specific functions to be performed by the minimum staff in an emergency include the following:

- Implement alarm response, plant response, and emergency management procedures
- Ensure that the plant reaches and is maintained in a safe-state condition
- Staff emergency operations center
- Make initial prompt notifications
- Communicate facility status, and respond to questions
- Support the DOE Office of River Protection
- Classify events
- Perform administrative functions such as preparing occurrence reports

5.5 Technical Safety Requirement Derivation

5.5.1 Limiting Condition for Operation – C5 Ventilation Exhaust System Operability

Purpose. This control, based on several accidents in section 3.4.1, ensures the C5 ventilation exhaust system's operability. Without controls, the release of aerosols exceeds the radiation exposure standards (RES) for the facility worker, co-located worker, and the public. The C5 area ventilation exhaust system provides secondary confinement of released aerosols. The C5 ventilation exhaust system draws flow from process areas and directs releases to the exhaust stack. The C5 fans maintain cascade airflow from lesser contaminated areas to higher contaminated areas; therefore, the fans will maintain the C5 areas' pressure negative to the C2 and C3 areas. Drawing flow from the C5 areas through the C5 ventilation exhaust system maintains cascade airflows and minimizes the facility worker exposure to a release. The C5 high efficiency particulate air (HEPA) filters will mitigate any potential releases and maintain co-located workers and the public exposure below the RES.

The C5 ventilation exhaust system TSR operability requirements include the following elements:

- Two C5 ventilation exhaust system fans, and their associated safety controls instrumentation systems, shall be operable.
- One C5 ventilation exhaust system fan, and its associated safety controls instrumentation system, shall be operating to direct aerosols to the exhaust stack.
- C5 ventilation exhaust system fans shall be supplied with SDC power.
- C5 HEPA filter banks shall have an efficiency of at least 99.9 % for particles of 0.3 microns.
- C5 safety control instrumentation systems shall be supplied with HLW SDC UPS power.

~~HLW SDC DC power system shall be operable to provide power to the SDC switchgear.~~

Surveillances related to this LCO include the following elements:

and radiological exposure standards for the facility worker and co-located worker. The offgas treatment system draws gas from the melter and directs releases to the exhaust stack. This prevents facility and co-located worker exposure to the chemical and radiological releases.

The offgas treatment system TSR operability requirements include the following elements:

- Three melter offgas treatment system extract fans and their safety controls instrumentation systems shall be operable.
- Three melter offgas booster fans and their safety controls instrumentation systems shall be operable.
- Two melter offgas treatment system extract fans and their safety controls instrumentation systems shall be operating to direct melter offgas to the exhaust stack.
- Two melter offgas treatment system booster fans and their safety controls instrumentation systems shall be operating to direct melter offgas to the exhaust stack.
- The melter offgas treatment system fans shall be supplied with SDS power (supplied by SDC power system).

~~The HLW SDC DC power system shall be operable to provide power to the SDC switchgear.~~

- The melter offgas treatment system extract and booster fans safety controls system shall be supplied HLW SDC UPS power and SDC power (from the BOF).
- The melter offgas treatment system booster fans safety controls system shall be supplied HLW SDC UPS power and SDC power (from the BOF).
- The melter offgas treatment system HEPA filter inlet heaters and their safety controls systems shall be operable and shall maintain differential temperatures across the heater before entering the HEPA filters.
- The offgas treatment system HEPA filter banks shall have an efficiency of at least 99.9 % for 0.3 micron particles.
- The differential pressure monitoring instrumentation and alarm on the HEME shall be operable.

Surveillances related to this LCO include the following elements:

- Periodic functional tests of the melter offgas treatment system extract fans
- Periodic functional tests of the melter offgas treatment system booster fans
- Periodic verification that two melter offgas treatment system extract fans are operating
- Periodic verification that two melter offgas treatment system booster fans are operating
- Periodic functional tests of the melter offgas treatment system extract fan safety controls instrumentation systems (including the variable frequency drives)
- Periodic functional tests of the melter offgas treatment system booster fan safety controls instrumentation systems (including the variable frequency drives)
- Periodic instrument loop calibrations and instrumentation loop checks of the melter offgas treatment system HEPA filter inlet heater safety controls instrumentation
- Periodic functional tests of the melter offgas treatment system HEPA filter inlet heater safety controls system

- The gamma detector at the cask lidding stations shall be operable.
- The interlock between the gamma detectors and the bogie motors shall be operable.
- The bogie motors shall be operable.

A failure of the bogie interlocks can result in exposing facility workers to radiation.

Surveillances related to this LCO include the following elements for all interlocks as appropriate:

- Periodic functional tests of the signals/sensor/detectors
- Periodic instrument loop calibrations of the signals/sensor/detectors
- Periodic verification that the bogie electromechanical actuator/motor/brakes are operable

These controls apply to the HLW facility in the TBD modes.

Derivation Criteria: This control was selected to prevent unacceptable radiological exposures to the facility worker.

5.5.11 Limiting Conditions for Operation – Pulse Jet Ventilation System Operability

Purpose: This control, based on several accidents in section 3.4.1.7, Hydrogen Explosion Accident, ensures the pulse jet ventilation system's operability. Without controls, induced releases of hydrogen gas trapped in the liquid waste could be instantaneously released, and a hydrogen deflagration or detonation could occur. The pulse jet ventilation system draws exhaust air from the pulse jet mixers, which cannot operate properly if the exhaust flow is blocked. The pulse jet ventilation system will ensure proper exhaust flow from the pulse jet mixers. The pulse jet mixers provide a controlled release of stored hydrogen to prevent a hydrogen deflagration. Drawing gas through the pulse jet ventilation system HEPA filters will mitigate potential releases and maintain co-located worker and public exposure below the RES.

The pulse jet ventilation system TSR operability requirements include the following elements:

- Three pulse jet ventilation system extract fans and their associated safety control instrumentation systems shall be operable.
- Two pulse jet ventilation system extract fans and their associated safety control instrumentation system shall be operating.
- The pulse jet ventilation system extract fans shall be supplied with SDC power.
- ~~The HLW SDC direct current (DC) power system will be operable to provide power to the SDC switchgear.~~
- The pulse jet ventilation system HEPA filter inlet heaters and its associated safety control systems will be operable and will maintain differential temperatures across the heater before entering the HEPA filters.
- The pulse jet ventilation HEPA filter banks shall have an efficiency of at least 99.9 % for particles of 0.3 microns.
- All safety control system instrumentation shall be supplied with HLW SDC UPS power.

Surveillances related to this LCO include the following elements:

- Periodic verification that two pulse jet ventilation extract fans are operating
- Periodic functional tests of the pulse jet ventilation extract fan safety control instrumentation system (including the variable frequency drives)
- Periodic instrument loop calibrations and instrumentation loop checks of the pulse jet ventilation HEPA filter inlet heater instrumentation
- Periodic functional tests of the pulse jet ventilation HEPA filter inlet heater safety control system
- Periodic verifications that the pulse jet ventilation HEPA differential airflow temperature is greater than or equal to a predetermined value
- Periodic verification that the pulse jet ventilation HEPA banks have an efficiency of at least 99.9 %

Operability requirements and surveillances on SDC power are required. For HLW systems these are covered in a separate LCO, and for non-HLW systems they will be implemented by the BOF PSAR and TSRs. Upon completion of those documents, they will be referenced here.

These controls apply to the HLW facility in all modes.

Derivation Criteria. This control was selected to prevent failure of the pulse jet mixers, which prevents a hydrogen deflagration in the concentrate receipt vessels and the plant wash and drains vessel.

5.5.12 Limiting Conditions for Operation – Safety Design Class Electric Power Operability

Purpose: This control ensures the SDC electric power system operability. This control supplies backup electric power to SSCs credited with having SDC/SDS power. Without controls, these SSCs would not be able to perform their safety function as credited in the accident analysis.

Three SDC electric power systems are credited in the analysis.

- SDC power – This system is made up of the emergency diesel generators at the BOF. The controls for these diesels will be in the BOF PSAR and TSRs. No further development of this system is provided in this chapter.
- HLW SDC UPS power – This system is made up of two UPS systems (A and B). Each UPS consists of a battery set (sealed batteries), inverter, charger, static auto transfer switch, manual bypass switch, regulating transformer, and distribution panels.
- ~~HLW SDC DC power – The DC power supply system is made up of three 125VDC batteries (sealed) assigned to HLW load groups A and B and SDC load groups A, B, and C. The batteries are maintained on a continuous float charge by a dedicated charger/rectifier.~~

The TSR operabilty requirements for the SDC electric power (HLW systems only) include the following elements:

- SDC power (emergency diesel generators at the BOF) shall be operable.

- The HLW SDC UPS power supply system shall be operable.
- ~~The HLW SDC DC power supply system shall be operable.~~

Surveillances related to this LCO include the following elements:

- Periodic functional tests of the batteries and all applicable components for both systems
- Periodic verification that both SDC electric power supply systems are operable.

Surveillance requirements for the BOF diesel generators are controlled by the BOF TSRs. There will be a requirement in the BOF TSRs to notify the HLW control room if SDC power is inoperable.

5.5.13 Administrative Controls

ACs are established as necessary to support operating limits provided by safety limits, limited control settings (LCS), and limiting conditions for operations (LCO). They also provide requirements that maintain the safety basis of the facility as described in the safety basis documentation. Note that no safety limits or LCSs have been identified for the HLW facility.

5.5.13.1 Administrative Controls - Source Inventory Receipt Acceptance Program

Purpose: The need for a source inventory receipt acceptance program is derived from a key assumption of the hazard and accident analysis relied upon to reduce the HLW facility radiological risks to acceptable levels. The hazard and accident analysis assumes that the source inventories received at the HLW facility are within specification before the feed is processed further. Numerous ACs at the PT facility protect this assumption (section 5.7.1). In addition, the HLW facility will have its own source inventory receipt acceptance program, to further reduce the likelihood of processing out-of-specification feed. Key elements of this program include:

- A source term receipt acceptance program shall be established, implemented, and maintained to ensure that the WTP accepts only hazardous and radiological waste authorized in the WTP Safety Analysis Report (SAR). NOTE: This program may be implemented at the PT facility for WTP-wide application.
- Acceptance criteria will be established to ensure that radiological and hazardous material inventories in waste streams received by the WTP are limited to reflect those source terms analyzed in the WTP SAR.
- Procedures will be established to ensure that waste receipt transfers meet WTP waste receipt acceptance criteria.
- Record keeping requirements will be established to ensure that records are maintained and available for review, and to document that waste material received into the WTP meets the waste receipt acceptance criteria.

Derivation Criteria: This AC was established to ensure that facility worker doses do not exceed the exposure standards identified in the SRD.